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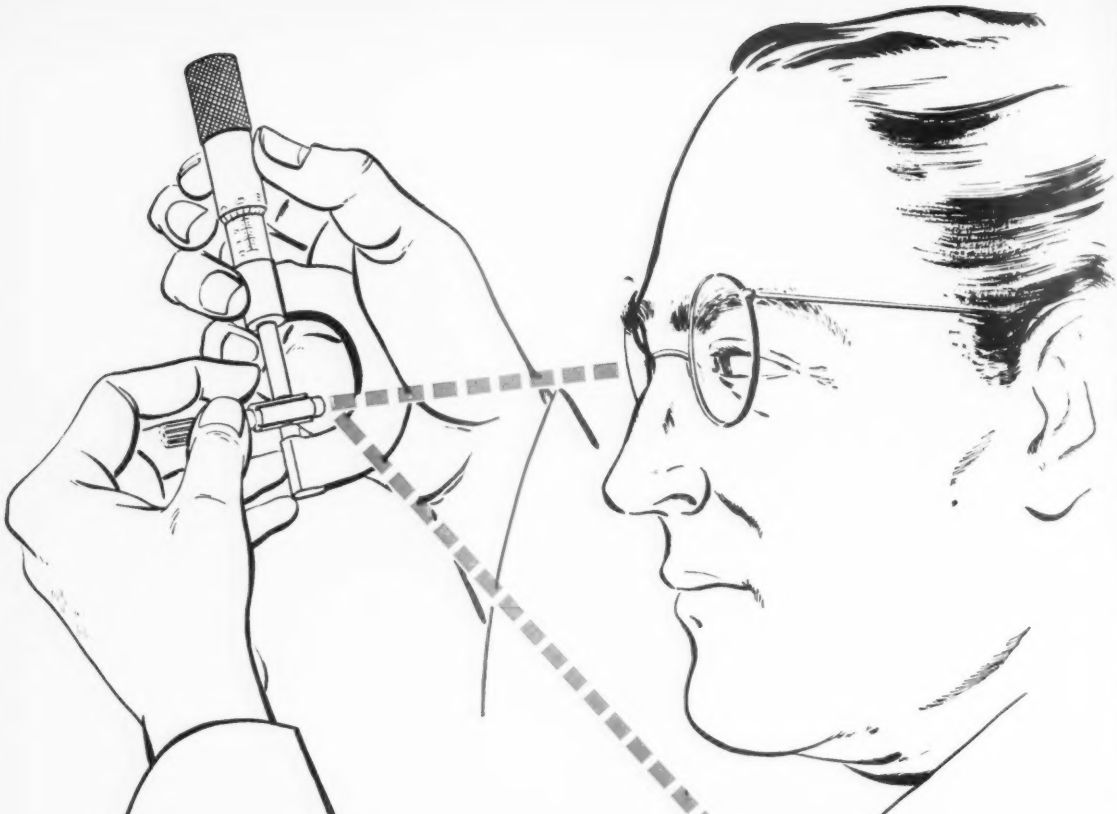

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Aircraft Engine Gage Unit

C. H. RIDGLEY* and J. L. THEISEN†

General Electric Company

C. H. Ridgley.

J. L. Theisen.

ABSTRACT

The engine gage unit for aircraft is a combination of three indicating instruments in a single case. The measurements made are oil temperature, oil pressure, and fuel pressure; three fundamental conditions of a gasoline engine which need to be checked at intervals and as quickly as possible. The physical grouping of the pointers makes a quick check possible.

The physical appearance and mechanical design of the engine gage unit have changed several times since the first one was used. The latest form, incorporating up-to-date principles of operation, conforms to present-day requirements for standardization of size and shape and to new specifications for performance.

The temperature indication is obtained with a remote electrical system, using a ratio-type electrical indicator actuated by a resistance-type thermometer bulb. The pressure indications are obtained with direct-reading mechanisms, with pipe lines transmitting the actual pressures to the instrument. The oil-pressure gage uses a pressure-sensitive bellows and a gear multiplication of motion to the pointer. The fuel-pressure gage is a differential indicator using pressure-sensitive diaphragms and a gear multiplication of motion.

Advancements in engine gage unit design to meet new specifications and to facilitate quantity manufacture have been in keeping with the general advancement in aircraft instrumentation.

INTRODUCTION

THE AIRCRAFT ENGINE gage unit owes its existence to the need for reduced instrument panel space and for simplification of indications of three important engine operating conditions. Instead of having three separate instruments for lubricating oil temperature, lubricating oil pressure, and fuel pressure, the pilot is provided with one that has three pointers so arranged on the dial face that operating conditions of each engine may be checked at a glance.

DESIGN PROGRESS

This combination of three indications has been used in aircraft for many years, but the instruments have gone through many design changes that are best described by referring to four salient features: (1) physical arrangement of indicating scales; (2) direct or remote indication of pressures; (3) direct-connected vapor pressure thermometers or remote electrical indication of temperature; (4) ranges of temperature and pressure.

In some of the earliest engine gage units, three separate units, each with its own enclosing case, were mounted on a common frame so that the scales were arranged in some desired relation. Fig. 1 shows an early instrument with the three indicators arranged vertically. This arrangement evidently saved panel space and related the three indications by having them in a line, but the separation of the three scales required that the pilot glance at each before he had obtained his information. Engine gage units of more recent design have the three elements mounted in a single enclosing case with the three pointers so located on the dial that the pilot can determine their positions by a single glance. This arrangement in the modern engine gage unit is illustrated in Fig. 2.

Fig. 1. An early form of engine gage unit.

The pressure elements of practically all engine gage units produced up to the present time have been direct-connected by pressure tubing to the engine. Most of the pressure-sensitive units for both the oil- and fuel-pressure elements have been Bourdon tubes of various sizes and shapes, and the pointer-operating mechanisms, temperature compensation, etc., have been peculiar to each manufacturer. Before the advent of high speeds, high-altitude flying, and the modern carburetors in aircraft, a single fuel-pressure connection was sufficient. In recent years, however, it has become common practice to make connections to the carburetor as well as to the fuel line, and to measure the difference between these two absolute pressures by a differential pressure element, rather than merely measuring the pressure of the fuel above atmospheric.

All of the early designs of engine gage units measured the oil temperature by Bourdon tubes direct-connected to va-

Presented at the National Fall Meeting, I.A.S., Dayton, Ohio, November 9–10, 1944.

* Time Switch Engineer.
† Aircraft Instrument Engineer.

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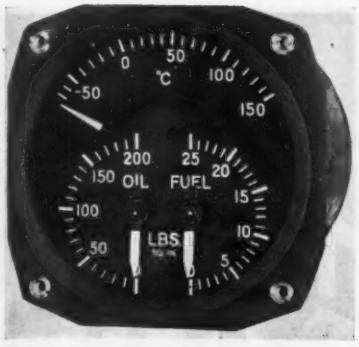

Fig. 2. Front view of the General Electric engine gage unit, type GA-1.

por-pressure bulbs in the oil line. This arrangement has been universally replaced by remote-indicating electrical thermometers using a resistance-type thermometer bulb in the oil line connected to a d.c. indicating instrument in the engine gage unit. The modern indicating instrument is of the moving-magnet ratio type.

Common scale ranges in early engine gage units were zero to 6 or 10 lbs. per sq.in. fuel pressure, zero to 100 lbs. per sq.in. oil pressure, and zero to 100°C. oil temperature. Progress in engine design, lubricating-oil operating characteristics, the use of turbosuperchargers, and overall performance requirements of aircraft have demanded changes in scale range and in the conditions under which these instruments must operate satisfactorily. Scale ranges are now required to be zero to 25 lbs. per sq.in. differential fuel pressure, zero to 200 lbs. per sq.in. oil pressure, and −70°C. to +150°C. oil temperature. Requirements for satisfactory operation under short-time applications of overpressure have been extended and the ambient temperature range has increased greatly. The present-day engine gage unit must withstand an oil pressure of 600 lbs. per sq.in. and must operate properly in ambient temperatures between −54°C. and +71°C. Since vibration frequencies on present aircraft are higher than on earlier planes, the modern engine gage unit must perform properly with vibrations up to 3,000 cycles per min. By fulfilling all these requirements, and by maintaining nominal scale errors less than 2 per cent of full scale, the modern engine gage unit justifies the confidence that pilots have learned to place in present-day aircraft instrumentation.

A Modern Engine Gage Unit

The operational specifications, briefly described in the preceding paragraphs, and the external appearance and dimensions all adhere to Army-Navy specifications. These result in the overall appearance of the modern engine gage unit as shown in Fig. 2 and in the cutaway view, Fig. 3. The case is solid black molded plastic and is attached to the cast brass base with four flat head screws. The window is assembled into the case from the inside and held with a snap ring. Referring to Fig. 3, the base "B" is the structural member on which all three indicating elements are mounted. The quarter-section of the base shows how the electrical connections are made to the engine gage unit and one of the three pressure inlets is shown in section. In the general design, the three elements contained in the engine gage unit have been treated as independent instruments insofar as possible. The temperature indicator is completely removable as a separate electrical instrument, as shown in Fig. 4, and it carries its own scaleplate.

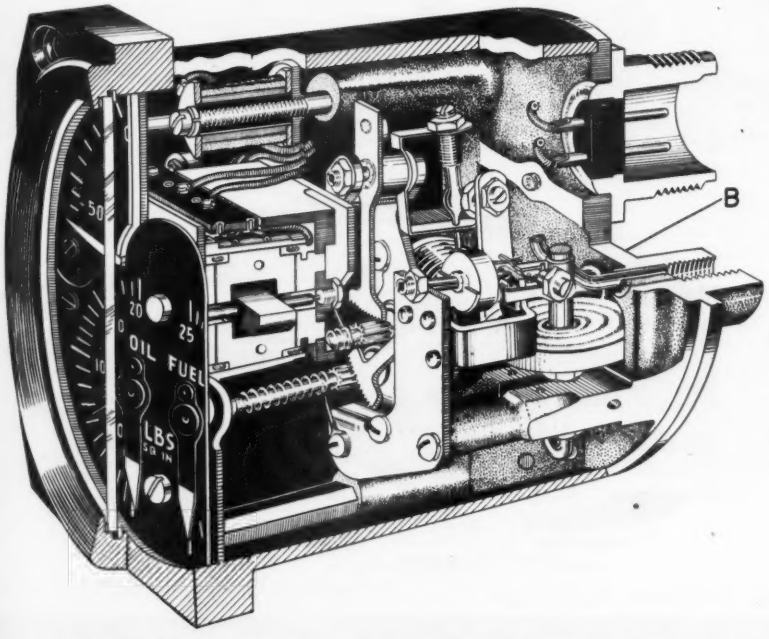

Fig. 3. Cutaway view of engine gage unit, General Electric type GA-1.

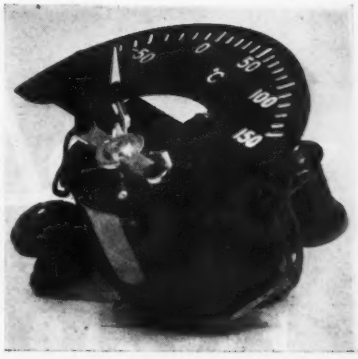

Fig. 4. Temperature indicator for General Electric engine gage unit.

Pressure Elements

Several important factors that required careful consideration in the design of the two pressure elements were: vibration characteristics; ability to withstand the high overpressures specified; simplicity of construction; and ease of adjustment.

A design in which the two pressure elements are entirely independent facilitates repair and replacement; however, such a construction is heavier and less rigid and complicates the scale design. Therefore, in the unit illustrated in Fig. 3 both pressure elements are mounted on a common base and have a common scaleplate. This base is made of a high-strength brass alloy, cast by the plaster of Paris mold process, and its important mounting surfaces are accurately machined. This provides sufficient strength to withstand the forces applied when installing the unit and the internal stresses of overpressure. The use of brass facilitates soldering the connections to the pressure elements.

Oil Pressure Element

The schematic view (Fig. 5) and the photograph (Fig. 6) show the mechanical construction of the oil-pressure element. The pressure-sensitive unit of this element is a brass bellows ("B," Fig. 5) which is satisfactory from the standpoint of drift or creep and ability to withstand the overpressure if its motion is restrained by the strong spring ("S"). This combination gives a high spring rate that minimizes the effect of the vibration frequencies to which these instruments are subjected.

The restraining spring ("S") is of a cantilever type, its free end being used as the point from which the motion of the bellows is transmitted to the pointer shaft. With proper selection of bellows characteristics, spring constants, and lever arms, the end of the spring moves about 0.035 in. for full-scale pressure. Fig. 7 shows three representative characteristics—those of the two component parts and their working combination.

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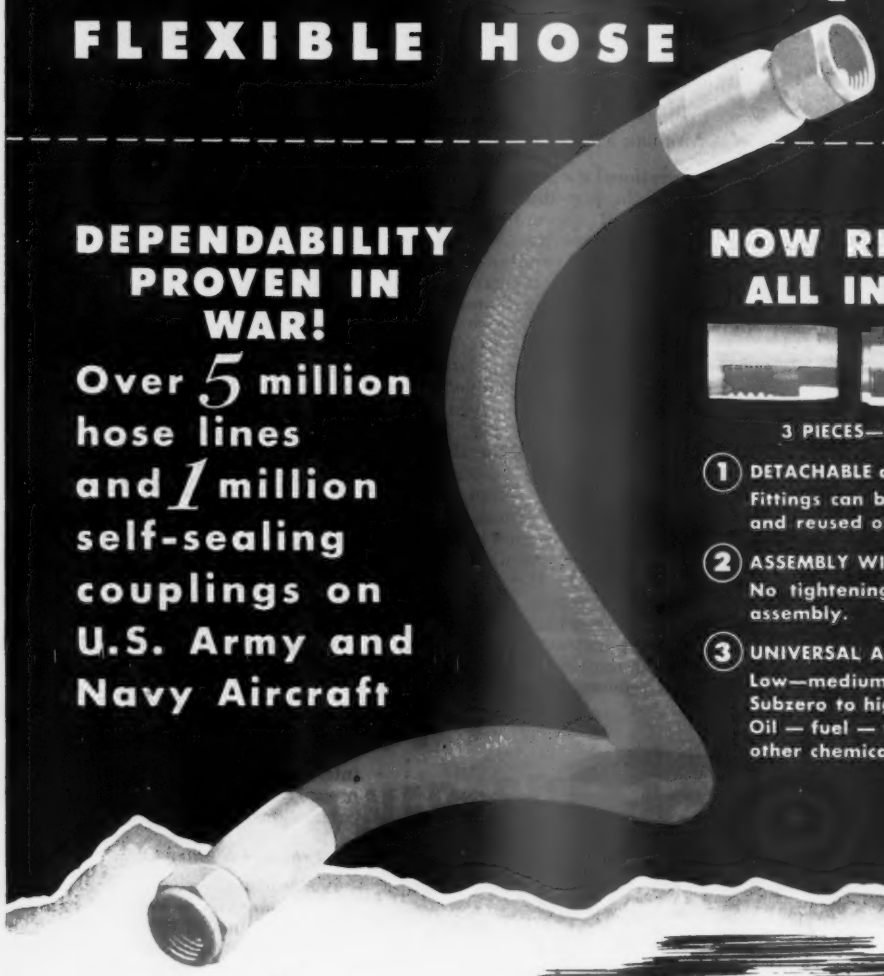

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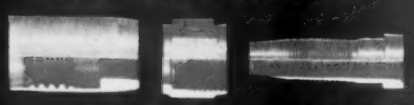

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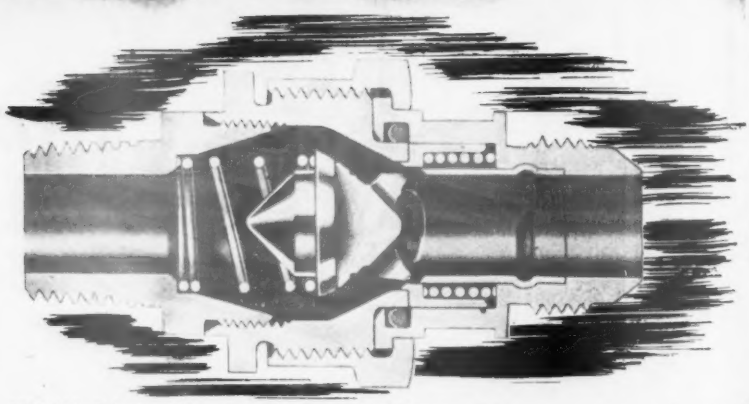

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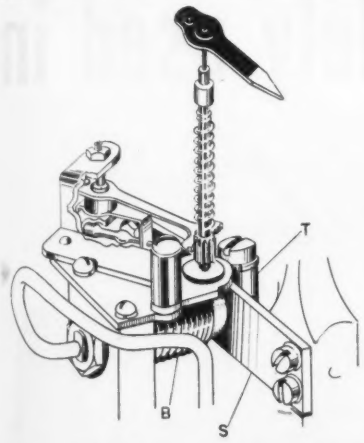

Fig. 5. Schematic view showing mechanical construction of oil pressure element.

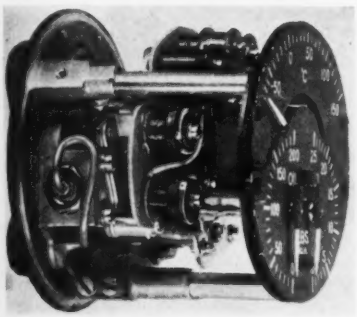

Fig. 6. Side view of engine gage unit showing oil pressure element and temperature indicator.

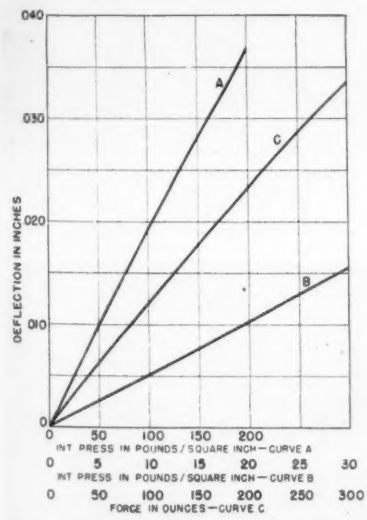

Fig. 7. Characteristic curves of oil pressure element components: Curve A—Pressure-deflection characteristics of combination of bellows and spring. Curve B—Pressure-deflection characteristic of bellows. Curve C—Force-deflection characteristic of spring.

A rigid but adjustable stop ("T," Fig. 5) fastened to the base, limits the motion of the spring and bellows to slightly more than full-scale travel when overpressure is applied and prevents these critical parts from being overstressed at the higher pressures. Importance of the base rigidity and maintenance of bellows and spring positions may be recognized from the fact that calibration is affected by an excessive amount if these parts change position by as much as 0.0035 in. during overpressure, hot and cold cycles, handling and shipment, or normal use.

The effect of ambient temperature changes on pressure-deflection characteristics of this element is controlled by making the cantilever spring from an alloy having a low temperature coefficient of modulus of elasticity. Since this spring represents about 70 per cent of the total spring constant of the system, the effect of temperature changes on the deflection of the brass bellows is small enough to maintain the variation in the indication within specified limits without additional compensation.

Conversion of the 0.035-in. motion of the end of the spring to 180° angular motion of the pointer is accomplished through a single adjustable lever arm and a single fixed 18:1 gear ratio, which are clearly shown in Fig. 5. A low-torque, helically wound spring is attached to the pointer shaft to take up backlash and maintain contact between the adjusting screw and the pusher surface on the end of the cantilever spring. The backlash spring is arranged so that the pointer follows the bellows motion up scale and is pushed down scale. This allows travel of the bellows and pusher beyond full-scale deflection on overpressure without straining the pointer mechanism.

The mechanism of the oil-pressure element has been kept as simple as possible and the design includes provision for easy adjustment.

Fuel-Pressure Element

The indication of the fuel-pressure element is the net difference between the absolute pressure at which the fuel is injected into the carburetor and the absolute air pressure in the carburetor. The mechanical construction of this element is shown in the schematic view (Fig. 8) and photograph (Fig. 9).

The pressure-sensitive unit (Fig. 10) consists of two identical 1-in. diameter capsules, each consisting of two corrugated beryllium copper diaphragms soldered together at their rims. These two capsules are mounted in mechanical opposition by being connected together with a solid rod. Pressure is introduced into the capsules through threaded tubes. These tubes are also used to mount the capsule assemblies in the base. A pusher plate, attached to the center rod, provides the point from which the net motion resulting from both pressures is transmitted to the pointer. The force and pressure-deflection characteristics of the capsules

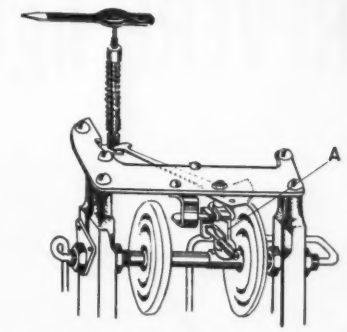

Fig. 8. Schematic view showing mechanical construction of fuel pressure element.

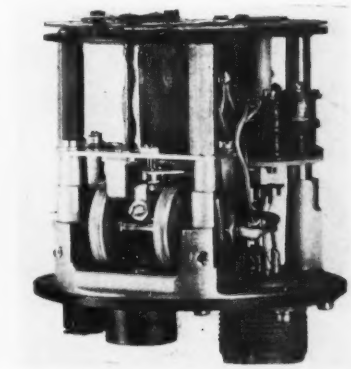

Fig. 9. Side view of engine gage unit showing fuel pressure element and temperature indicator.

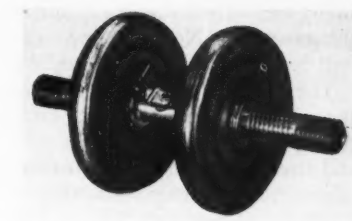

Fig. 10. Capsule assembly of fuel pressure element.

must be such that the conditions as illustrated in Fig. 11 are met. The motion resulting from this arrangement allows the use of a pointer-operating mechanism similar to the one on the oil-pressure element, except for dimensional details. A backlash spring is used on the pointer shaft in the same manner as on the oil-pressure element.

The manufacture of the diaphragms and the assembly of the pressure capsules for the fuel-pressure element require extremely careful control of all operations. The soft beryllium copper strip for the diaphragms is given special laboratory tests for hardening and forming characteristics before it is released for manufacturing. The diaphragms are carefully blanked and formed in solid metal dies and, after being

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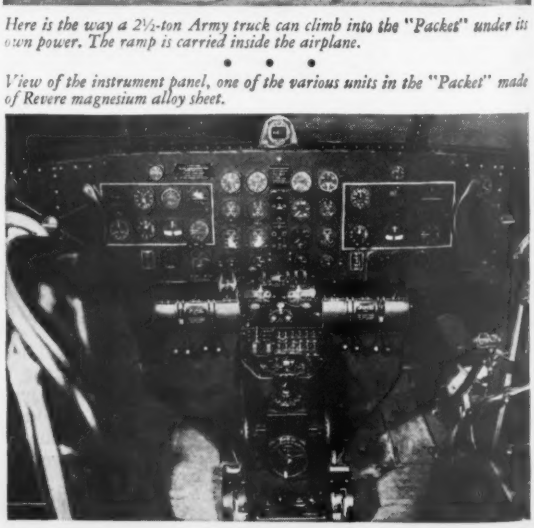

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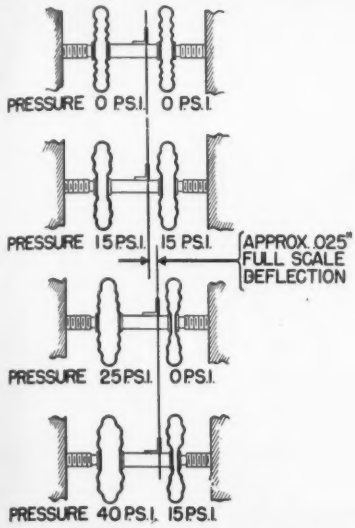

Fig. 11. Sectional drawings of fuel pressure element capsule assembly under various pressure conditions. Note importance of both force-deflection and pressure-deflection characteristics of each diaphragm.

trimmed, are inspected for dimensions and contour. They are then mounted in special fixtures to prevent warpage and age-hardened in a closely controlled vacuum furnace. Another inspection of dimensions and contour is then made, after which the diaphragms are given a force-deflection test and sorted into groups from which the capsule pairs are selected for uniformity. The capsule assembly (Fig. 10) is soldered together with the aid of special positioning fixtures.

Compensation for the effect of ambient temperature changes on the fuel-pressure indications is obtained by using bimetal supports for the lever-arm adjusting screw ("A" in Fig. 8). This makes the mechanism of the fuel-pressure element as simple as that of the oil-pressure element. Adjustments for pointer travel are made in the same way on both elements.

Friction in the pointer mechanisms of both pressure elements is inherently low because of the simplicity of the design. However, bearing and gear surfaces are polished and the gear mesh is adjusted to assure minimum friction.

In the manufacturing process the pressure elements are given stabilizing treatments that include temperature cycling, an application of overpressure, and 500 applications of full-scale pressure. These operations are performed simultaneously on a group of devices on a semiautomatic test stand. Final tests are made on pressure stands. Predetermined scales are used on both pressure elements. This is particularly advantageous for field servicing because both scales are on the same metal plate.

Temperature Indicator

The temperature indicator is of the remote-indicating electrical type and uses as its detector a resistance-type thermometer bulb. The characteristics of both the bulb and the indicator must be closely controlled to allow interchangeability.

The thermometer bulb (Fig. 12) consists of a wire-wound resistor encased in a steel tube. This bulb is screwed into the oil line of the engine and electrical connections are made between it and the temperature indicator. Fig. 13 shows the temperature-resistance curve of the thermometer bulb. An average lead resistance of 0.16 ohm is added to these values to prescribe the calibrating resistances for the various points on the temperature-indicator scale.

The indicating element of the temperature indicator shown in Fig. 4 is of the moving-magnet ratio type. The indication is provided by a permanent-magnet rotor, which is attached to the pointer shaft, rotating in a field produced by two sets of coils mounted perpendicular to each other in a die-cast frame. Referring to Fig. 14, coils C_1 and C_2 carry a constant direct current and coils M_1 and M_2 carry a variable direct current. This latter current depends upon the variation in resistance of the thermometer-bulb arm of the Wheatstone bridge circuit. The rotatable magnet aligns itself with the vector sum of the magnetic fields of the two coils just described. Fig. 15 shows

Fig. 12. General Electric thermometer bulb used with the engine gage unit for measurement of oil temperature.

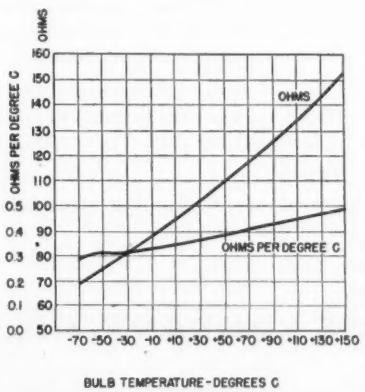

Fig. 13. Temperature-resistance characteristics of the thermometer bulb shown in Fig. 12.

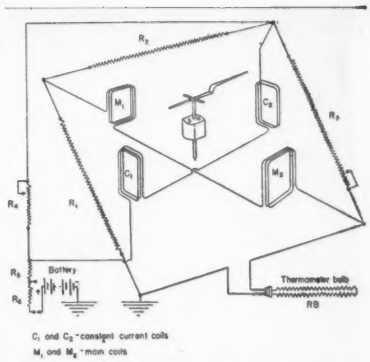

Fig. 14. Schematic diagram of remote-indicating system of temperature measurement, with ratio-type indicator connected in Wheatstone bridge circuit.

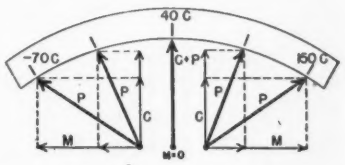

Fig. 15. Vector diagrams of flux from coils in the temperature indicator.

these vector relations. The center of rotation is shown in three positions for clarity.

Vector C—represents the flux from the constant-current coils. The length of this vector is affected by the flux distribution through the rotor.

Vector M—represents the flux from the main coils. The length of this vector is determined by the resistance of the thermometer bulb.

Vector P—represents the resultant flux with which the rotor and pointer are aligned.

A small "pull-off" magnet, which is located so that it exerts a constant torque on the rotatable magnet, returns the pointer to the lower end of the scale when voltage is removed. A magnetic shield, a metal cylinder of high magnetic permeability, serves to protect the instrument from the earth's field and to prevent interaction between the magnetic fields of this instrument and magnetic compass elements nearby in the plane.

One of the important features of this ratio-type instrument is the small effect of voltage variation on accuracy of indication. A reduction in voltage from 28.5 to 22.5 volts causes a maximum change in indication of from 3 to 6°C., depending upon the pointer position.

The temperature indicator is designed so that it can be built and adjusted as a complete instrument and then assembled into the engine gage unit after the pressure elements have passed preliminary tests. Although the design of the temperature indicator has several unique features, it is manufactured by conventional instrument methods. The

(*Continued on page 32*)

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Radio Noise in Aircraft Engines

ALFRED E. TEACHMAN*
Wright Field

SUMMARY

The growing importance of radio equipment in aircraft operations, both commercial and military, requires the complete elimination of engine-ignition radio noise. This is shown to be entirely possible. Characteristics of the ignition impulse and its radio-frequency effects are outlined. It is shown that resonant oscillations in the ignition system occur above 10 megacycles and that resistance wire ignition cable markedly reduces the intensity of these oscillations. Filters for magneto grounding circuits are found to have a limited value in the V.H.F. range. Shielding concepts and the principles of shielding design are presented with emphasis on the problem of obtaining continuity of the shield at joints and parting surfaces. Conducting gaskets of various types are described and the conditions that they must satisfy to achieve shielding effectiveness are stated. Some recent tests show wide differences in the shielding effectiveness of various types of flexible shielding conduit. Practical testing methods for the design engineer are suggested.

INTRODUCTION

SINCE THE DAYS of the earliest experiments with air-borne radio equipment, the radio interference created by the ignition system has been a serious problem. Without some form of suppression the operation of receiving equipment was all but impossible. The earliest experiments with shielding were seldom carried beyond the point of providing tolerable reception. When more sensitive receiving equipment was developed, attempts were made to improve the shielding but again only to the point where the radio noise could be tolerated. There seems to have been little attempt to explore the limits of shielding effectiveness.

During the past 10 years there has been little shielding improvement that might be classified as fundamental in nature. In fact, the original purpose of shielding seems to have been lost sight of and it is found that the principal changes and improvements were made for mechanical reasons. The ignition engineer and the mechanical engineer saw in the shielding system an excellent means of providing mechanical protection and a simple way of pressurizing the system for improved high-altitude performance. The theory of shielding was scarcely understood, as evidenced by the introduction of such innovations as rubber gaskets. While radio engineers burned the midnight oil to develop new and highly sensitive equipment, the ignition system was being slowly but surely turned back to a primitive spark transmitter. A crisis was reached when V.H.F. radio equipment was first installed. As will later be shown, the ignition system is an excellent transmitter at these frequencies. Since the problem was primarily the concern of radio engineers and could be solved only by those familiar with the art, the Aircraft Radio Laboratory at Wright Field was given the job of finding a solution.

Presented at the National Fall Meeting, I.A.S., Dayton, Ohio, November 9–10, 1944.

* Captain, Air Corps, Aircraft Radio Laboratory.

CHARACTERISTICS OF THE IGNITION IMPULSE

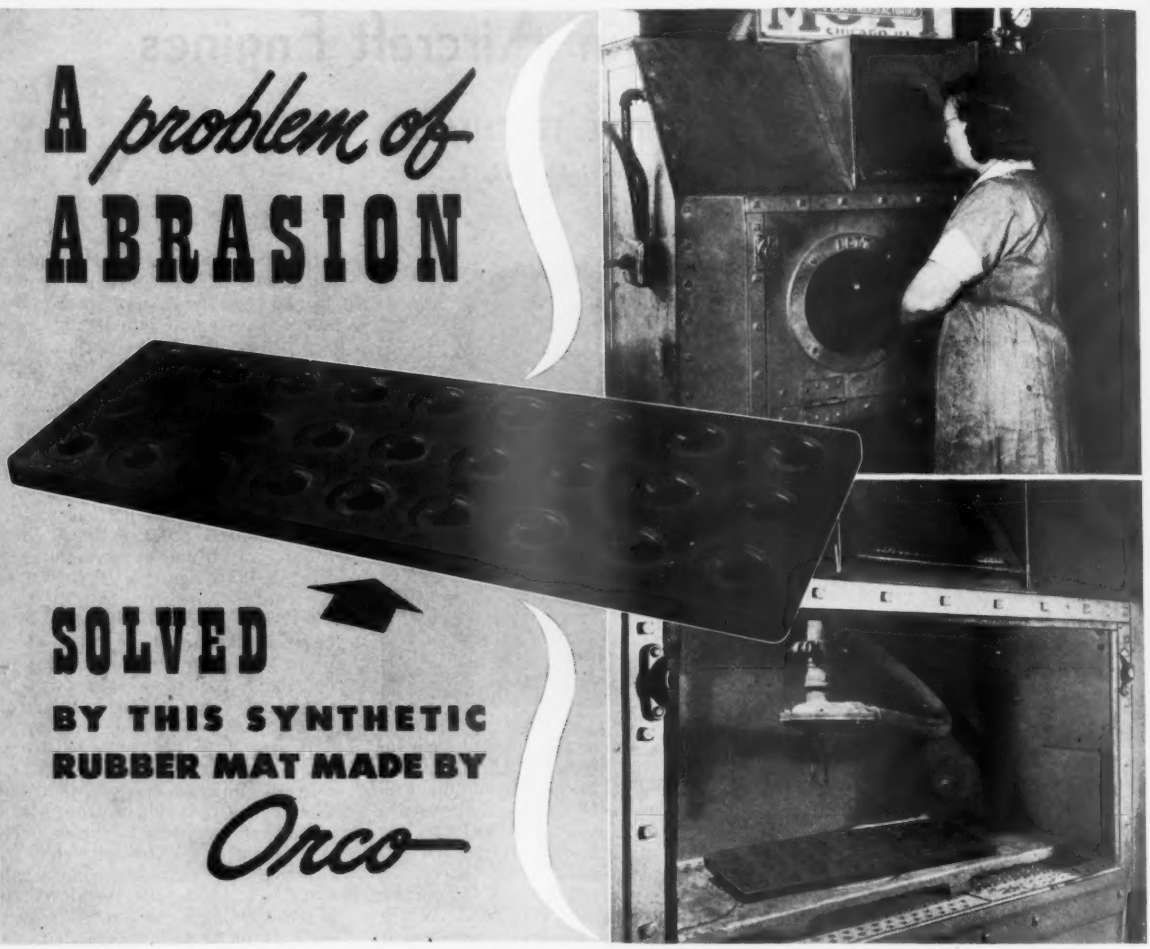
Discussion of the ignition radio-noise problem might well begin at that point in the cycle of magneto operation where the rotor has built up a strong electromagnetic field about the closed primary circuit. The breaker points are timed to open at this critical juncture, thus interrupting the flow of current in the primary circuit and causing a sudden collapse of the magnetic field about the primary and secondary windings. This induces a voltage in the secondary which is proportional to the number of turns and to the rate of magnetic collapse.

Theoretically, the magnetic field might collapse instantly causing the voltage to rise at an infinite rate, but the magnetic reluctance of the core and the time constants of the resistance, inductance, and capacitance associated with the secondary results in a finite rate of collapse and a corresponding rate of voltage rise in the secondary. Although this voltage gradient is quite steep, it is not sufficient to cause serious interference at very high radio frequencies. The greatest interference is caused by the almost instantaneous surge of current accompanying the voltage breakdown of the spark gap. The peak intensity of the discharge current has been estimated by some investigators to lie between 50 and 150 amp. This current is proportional to the capacitance in the circuit. In this connection, it should be mentioned that flexible shielding conduit has a capacitance of 15 to 20 $\mu\mu f$ per foot which, at voltages of the order of 10,000 volts, is capable of storing appreciable energy. The alarming figure of 50 to 150 amp. need not be taken too seriously, for the integrated power of a number of discharges taken over a period of time would be very low. Estimates have been made that the average power output of a large magneto is in the vicinity of 10 to 20 watts. Of this amount, only a small part is converted to radio energy. Further, the amount of power converted to radio energy is distributed over the entire radio spectrum with the result that the energy in any small band of frequencies is extremely small. By inserting a radio-frequency galvanometer in series with certain portions of the shielding harness, radio-frequency currents of 30 milliamperes have been measured. Again, it should be remembered that the current so indicated includes radio-frequency energy scattered over a broad band of the radio spectrum.

Analysis of the intensity of this radio-frequency energy versus frequency would be exceedingly difficult to make. However, some general characteristics are known. In the absence of resonant conditions, the discharge of current through a gap will set up an electromagnetic shock wave which, if intercepted by a resonant circuit such as the first tuning circuit of a receiver, will impart oscillation to the circuit and thus be detected. The steepness of the shock-wave front is sufficient to impart oscillation to resonant circuits from low radio frequencies well up into the ultra-high-frequency range. If the discharge of current takes place in an electrically resonant circuit, a decaying wave train of oscillations will follow at the frequency of resonance.

The circuits of an ignition system have numerous resonances that have a marked influence on the radio-noise potentialities. The high-tension cables of the ignition system are, in effect, transmission lines that are grossly mismatched as to correct terminating impedance, with the result that impulse excitation causes damped oscillations to take place. The fundamentals and harmonics of these oscillations are

A *problem of* ABRASION



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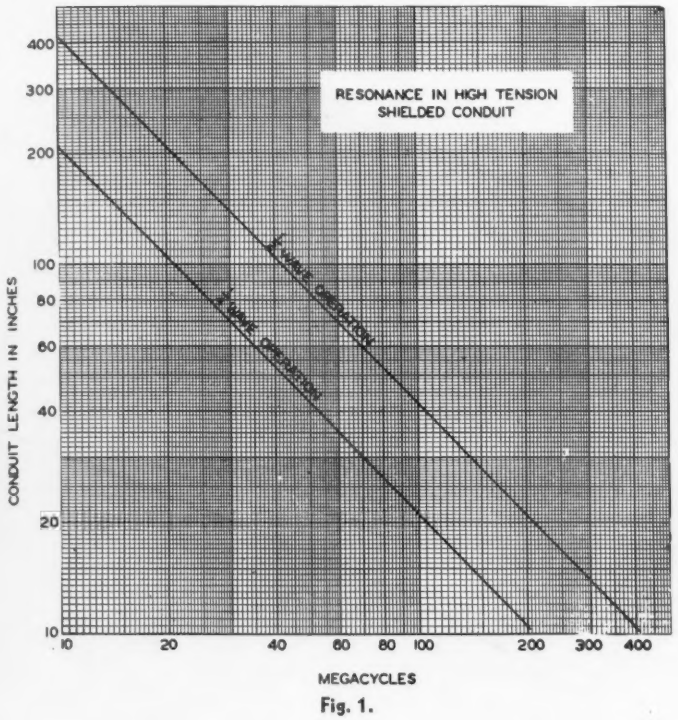


Fig. 1.

governed by the electrical length of the cables. The lowest fundamental resonance is given approximately by the formula

$$\lambda/4 = 2{,}952V/f$$

where

λ = length of wave in conductor (inches)
V = propagation constant (approx. 0.7 for a concentric line with air and rubber insulation)
f = frequency megacycles

Fig. 1 gives a graphic solution of the formula showing quarter-wave and half-wave resonances versus the conduit length in inches. (Conduit length and cable length are here used interchangeably.) Since cable lengths seldom exceed 150 in. (which for quarter-wave operation would resonate at 13.8 megacycles), resonant conditions are seldom found at lower frequencies. However, resonant conditions in the V.H.F. spectrum are markedly in evidence with the resultant reinforcement of radiation at these frequencies.

Resistance Damping

The production of radio-frequency oscillations in the ignition cables is incidental to the operation of the ignition system and not essential to its proper function. It is possible to provide electrical damping of these oscillations without adversely affecting the ignition system and thus reduce the radio noise. Two methods are readily available. One is by use of suppressor resistors located at the plugs and the other by employing high-resistance wire in the ignition cable.

Practical tests have been conducted to determine the effectiveness of resistance wire cable in reducing the intensity of oscillation. For this purpose, two standard tubular harnesses for an R-2800 engine were obtained, one wired with standard ignition cable and the other wired with resistance cable having a value of 180 ohms per ft. Each harness was separately tested on the starboard engine of a B-26 airplane. Great care was exercised to make certain that the harnesses were attached in an identical manner. All tests were made with radio noise meters installed in the airplane with their antennas projecting through the top of the fuselage. The noise meters used in these tests were the RCA Model 312-C and Measurements Corp. Model 58. The airplane was situated in the center of the flying field at a point farthest removed from all other sources of noise. The engine was operated at a constant speed of 1,500 r.p.m. Since the prime purpose of the test was to establish the difference between oscillation intensity of standard cable versus resistance cable, it was desirable that there be an appreciable leakage of ignition noise over and above the area noise at all frequencies within the spectrum of the test. To satisfy this condition it was necessary to remove some of the shielding in such a manner that the leakage produced would be fixed and comparable for both harnesses. This was accomplished by insulating one end of the shielding on the magneto high-tension lead and removing the distributor covers.

Fig. 2 gives the result of the test. The curious crossover that takes place at approximately 5.5 megacycles went unnoticed at the time data were being collected and is presumed to have been caused by a transmitter, the strength of which varied during the interval of the test. Neglecting this, the most striking information obtained from the graph is that the principal radiated noise lies above 10 megacycles and that no resonant conditions are in evidence below 13 megacycles. The greatest improvement caused by the resistance cable occurred in the frequency range where circuit oscillations are known to exist. Since the resistance is distributed throughout the cable, there will be resistance in every current loop no matter what the standing wave pattern. Unlike a resonant tank circuit, a resonant line circuit has distributed constants and it is, therefore, necessary that the resistance be distributed in order to have the maximum damping effect.

In the region below 10 megacycles the improvement is negligible and, although a crossover exists below 0.9 megacycle, it is so slight as to be of little significance. Bearing in mind the logarithmic presentation of the graph, it is of interest to compare the tremendous ratio of approximately 2 microvolts at 2 megacycles to 4,000 microvolts at 90 megacycles. In the range between 10 and 150 megacycles, the substitution of resistance cable yields an average noise voltage reduction of 17 to 1 which is equivalent to a 24 db. reduction in noise level. This indicates that almost any existing ignition system having undesirable leakage due to the shielding can be improved a substantial amount by a complete substitution of resistance wire cable. Recent tests have shown negligible improvement when only a portion of the cable is resistance wire.

It would be of interest to consider the problem above 150 megacycles but unfortunately suitable radio noise-measuring equipment is not available. However, it can be safely assumed that oscillations occur well up into the ultra-high-frequency spectrum.

It was desired to know the difference in damping effectiveness for the same amount of resistance lumped at the spark plug instead of being distributed throughout the high-tension cable. Theoretically, it appears that the resistor at the spark plug will be located at a voltage loop with respect to

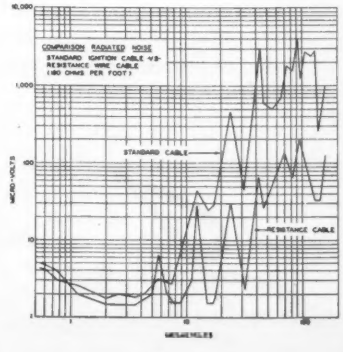
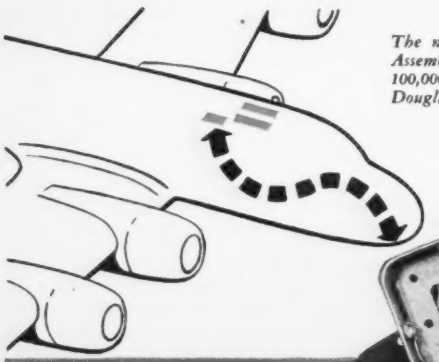


Fig. 2.



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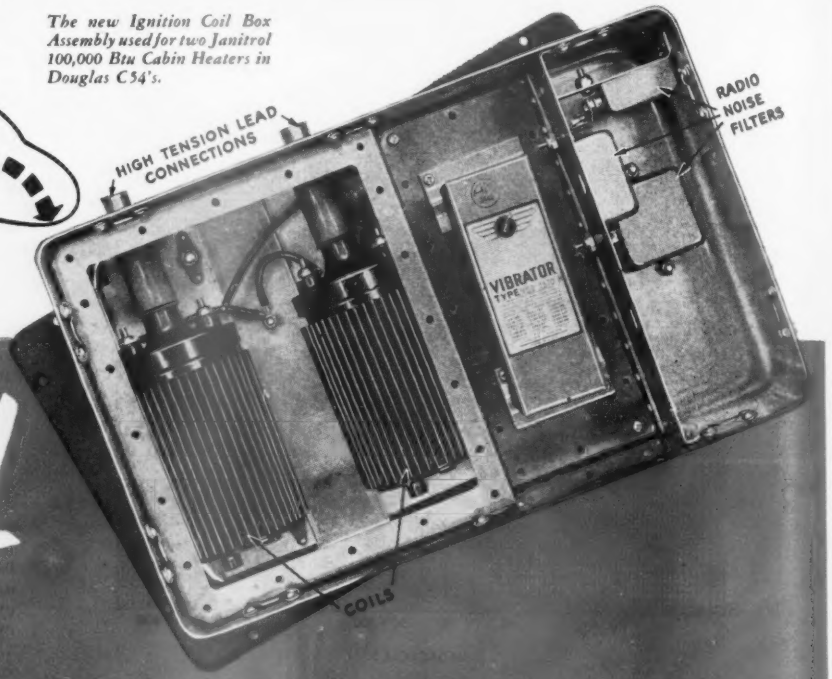

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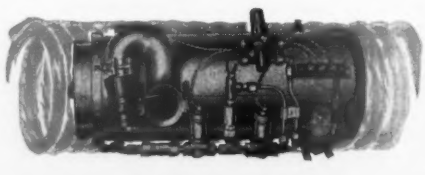

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circuit oscillation and will have little effect in dissipating the oscillating currents.

Distributed Resistance vs. Lumped Resistance

To make a comparison between the effectiveness of distributed resistance versus lumped resistance, a test arrangement was set up consisting of a shielded magneto and a shielded spark gap, with a length of shielded high-tension cable between. The length of cable was chosen to give 1,000 ohms total resistance for a cable having 180 ohms per ft. The resistor spark plug was also 1,000 ohms. A cylindric copper shield was inserted midway in the shielded line and a small transverse slit made in the cylinder. An electrostatically shielded probe coil was fastened in inductive relation to the leakage field at the slit and connected to Measurements Model 58 noise meter. The object was to compare the intensity of oscillation within the shield for four different conditions of operation:

(a) With standard high-tension cable and a standard plug.
(b) With resistance wire cable 180 ohms per ft. and a standard plug.
(c) With resistance wire cable 500 ohms per ft. and a standard plug.
(d) With standard high-tension cable and a 1,000-ohm resistor plug.

While the data so taken could not be directly compared with the radiation tests made on the R-2800 engine, it was nevertheless considered a satisfactory means of indicating the relative merit. The resonance conditions that are evident in these curves include nonuniform response of the measuring system. The test is therefore only comparative.

The results of the comparison tests between standard high-tension cable versus resistance wire cable are shown in the graph of Fig. 3. The reduction of oscillation intensity when resistance cable is used is clearly evident. The improvement caused by raising the resistance value from 180 ohms per ft. to 500 ohms per ft. is seen to be small.

In Fig. 4, comparison is made between a standard spark plug versus a

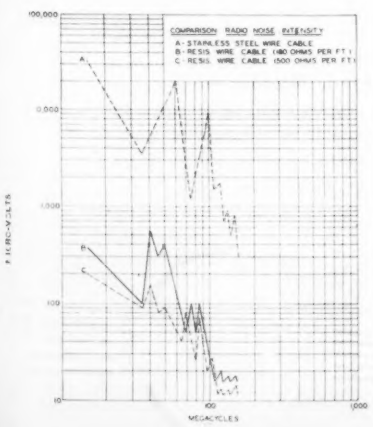
COMPARISON RADIO NOISE INTENSITY
A - STAINLESS STEEL WIRE CABLE
B - RESIS WIRE CABLE (180 OHMS PER FT.)
C - RESIS WIRE CABLE (500 OHMS PER FT.)
MICRO-VOLTS
MEGACYCLES

Fig. 3.

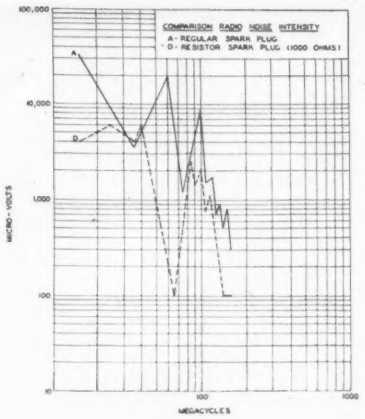

Fig. 4.

1,000-ohm resistor plug. Standard ignition cable was used in each case. The erratic and spotty nature of improvement is not clearly understood but it is evident that the same amount of resistance distributed in the cable is much more effective. Recalling the small improvement below 10 megacycles when resistance wire cable was used in the R-2800 engine, it may be surmised that the primary effect of resistor plugs in the reduction of radio interference is due to the fact that they limit the *initial* peak surge of current with corresponding reduction of the shock-wave intensity.

Magneto Grounding Circuit Filters

Installation of an aircraft engine places certain engineering responsibilities upon the contractor in relation to the connecting of magneto grounding circuits and starting induction vibrators to see that such circuits do not act as radiators of ignition interference which is conveyed back along the circuits from the magneto. In most of the airplanes produced to date the shielding of the magneto grounding circuits has not been carried out as well as it might have been, with the result that some interference is radiated by these circuits. While this can and should be taken care of by complete shielding of the circuits, the question is often raised as to the possibility of applying filters in the grounding circuit at the magneto, thus eliminating the need for further shielding. However, these are two severe limitations to such a plan which seem impossible to overcome. One is that, in the design of most magnetos a capacitor of approximately 0.2 microfarad is required across the magneto primary circuit. Because of magneto operating characteristics, this capacitance must remain within plus or minus 10 per cent of the design value. Accordingly, it is not permissible to use filters having a total shunting capacitance greater than 0.02 microfarad. Within this range of capacitance, it is not possible to build filters having the required attenuation characteristics in the low radio frequencies. The second difficulty is that the inductance and resistance of filter coils must be relatively low in order that the magneto primary circuit will be effectively shorted when the grounding switch is closed.

Conducted Noise Voltage

It was desired to know what intensity of conducted noise voltage existed on the magneto ground circuits from 0.2 to 150 megacycles. This might have been obtained with some difficulty from an actual airplane installation but, since the projected tests involved many hours of work, it was found desirable to build a test rig simulating the conditions to be studied. For this purpose a complete ignition system for an R-1820 engine was set up on a bench. The surface of the bench and backboard were covered with copper sheet. All spark plugs were inserted in spark chambers fastened to the ground plane and a means provided for pressurizing the spark chambers with nitrogen gas. Attached to the gas cylinder was a pressure reducing valve. The magnetos were driven through a gear train at normal rotational speed. A length of aluminum-type flexible shielded conduit, such as is commercially used for the purpose, was used to shield the ground lead of one magneto. The conduit was bonded at two intermediate points to the ground plane. The conditions obtained in the operation of this ignition system closely simulated conditions to be found in the average airplane installation.

The graph of Fig. 5 gives the conducted radio-noise voltage as measured with the shielded line in place but without a filter in circuit. The dotted line shows the results obtained with a typical filter. There are several things about this graph which are of special interest. One is the high order of intensity and the fact that the resonance conditions above 10 megacycles, which were found in the tests on the R-2800 engine, are also present in these curves. It is quite apparent that the oscillations of the high-tension cables find their way by various couplings and appear in the primary circuit of the magneto. Another thing worth noting is that, in contrast to the radiation tests on the

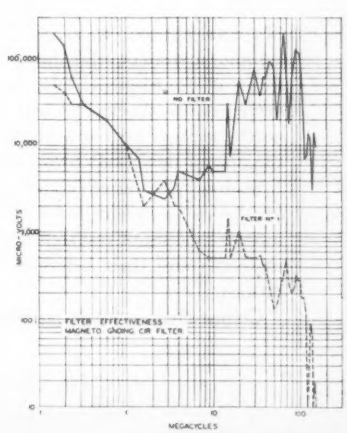

Fig. 5.

Investigating the grain structure of a metallurgical subject, magnified 585 times.

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R-2800 engine, the intensity of the noise voltage below 3 megacycles increases markedly with lower frequency. This, of course, is explained by the fundamental difference in the way the two tests were made since, in the present test, conducted voltage is being measured and not the radiation field. This freedom from radiation difficulties in the low-frequency part of the spectrum is merely due to lack of effective radiation means.

The main conclusion drawn from these tests is that, within the capacitance limit of 0.02 microfarad, it is possible to build filters having between 20 and 60 db. attenuation over the range of 10 to 150 megacycles. Such filters can be attached readily and quickly in existing airplanes with corresponding reduction of radio noise in the V.H.F. range when such radio noise is due to an improperly shielded magneto ground system. There is considerable doubt that suitable filters can be built which will reduce the conducted noise voltage to a point low enough to permit complete removal of the shielding. A much better job can be done if, at the time a magneto is designed, some thought is given to incorporating the entire primary capacitance in a suitable pie-section filter. This would have the great advantage that each of the two capacitors in the filter would be of the order of 0.1 microfarad. If the capacitors were of good radio frequency design their effectiveness would be markedly greater, and it is believed that the R.F. choke section of the filter would have little, if any, effect on the magneto frequency purposes of the capacitor.

In passing from this subject there are two thoughts that seem worthy of further consideration. The first is, that it seems odd to use a heavy, bulky, and expensive shielded electrical circuit to accomplish a switching operation that, with less weight, bulk, and complication might be more easily and safely done with a switch located at the magneto and controlled by a small steel draw wire. The second thought is along the same line, except that a relay switch completely housed in a copper box located on the magneto could be operated with a solenoid external to the shield. By such an arrangement, the contacts associated with the magneto would be completely shielded and it would be wholly unnecessary to shield the relay control wire.

Shielding

The method that holds almost limitless possibilities in the suppression of ignition radio noise is the use of shielding. It is desirable at this point to formulate some shielding concepts. The most important concept is the surface nature of radio-frequency currents. These currents flow on or near the surface of conductors rather than through them. Direct currents or very low frequency alternating currents, on the other hand, flow rather uniformly through the entire cross section of a conductor.

The reason for this phenomenon can be explained by considering the action of the electromagnetic field which always accompanies the flow of current in any conductor. For a steady-state direct current the magnetic field surrounding the conductor is stationary, being most intense at the very center of the conductor and growing rapidly weaker as the distance from the center of the conductor increases. If we consider the conductor to be composed of many thousands of parallel conducting filaments, it will be seen that the rise and fall of the magnetic field accompanying the flow of an alternating current will cause a higher reactive voltage to be generated in the central filaments of the conductor than in the surface filaments, since the interior filaments are cut by all the magnetic lines of force, whereas the exterior surface filaments are cut only by those lines of force exterior to the conductor. As a result, the central filaments of the conductor will have higher self-inductance than the filaments near the surface and the current will choose the lower impedance path near the surface. This disproportionate amount of self-inductance between the surface filaments and the central filaments of radio-frequency conductors becomes more marked with increasing frequency, the result being that, for very high frequencies, the surface filaments carry nearly all of the current. This is known as "skin effect." It can be shown that the same effect takes place when a radio-frequency wave impinges upon a shielded wall or in a concentric shielded line where the currents will flow on the inside surface of the surrounding shield.

Viewed in cross section, the current density in a conductor falls off exponentially with increasing depth. Theoretically, it never reaches zero, but, for all practical purposes, falls to an insignificant amount in a relatively short distance. For computation purposes it is customary to compare the degree to which various metals are penetrated by reference to the "effective depth of penetration." The effective depth of penetration is defined as that depth at which the current density has fallen to $1/e$ or approximately 37 per cent of the surface current in a conductor of infinite thickness. This depth is equivalent to a conducting shell that would have the same resistance to direct current as the complete conductor would have to alternating current.

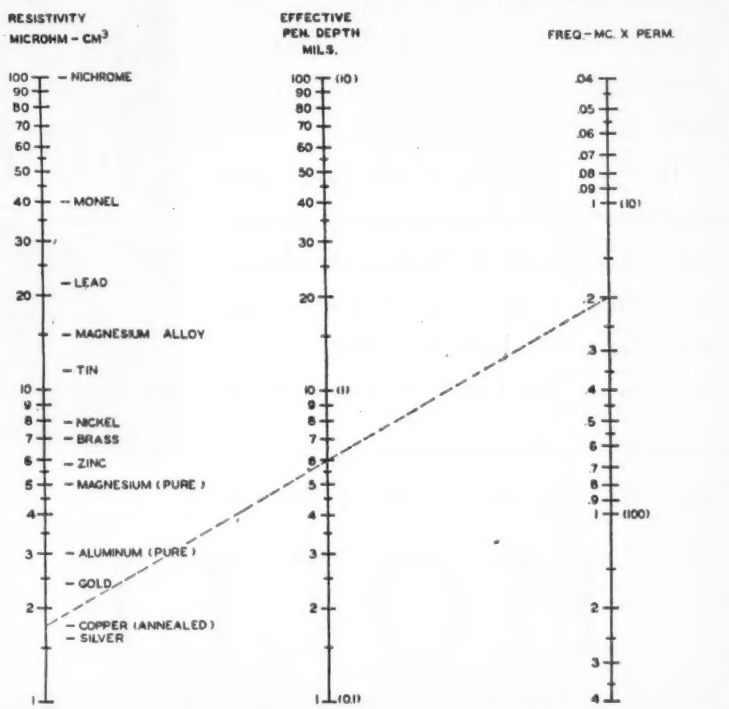
The depth of penetration depends upon the frequency, resistivity, and permeability. These are related in the formula

$$d = 1{,}980 \sqrt{p/uf}$$

where

d = effective depth of penetration in in.
p = resistivity in ohms-cm.[3]
u = permeability
f = cycles per sec.

It is seen that the effective depth of penetration varies inversely as the square root of frequency. This means that, for any relatively thick conductor or shielding wall the effective depth of penetration at 100 megacycles will be one-tenth that at 1 megacycle. In nonmagnetic metals the permeability factor is 1. The computation for depth of penetration in magnetic metals is less



Courtesy Bendix Scintilla

Fig. 6. Nomograph for determining depth of penetration.

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reliable since permeability is a complex factor about which little is known at radio frequencies. However, since most magnetic metals have high resistivity, the effective permeability at radio frequencies must be high enough to offset this disadvantage. For ease of computation the nomograph of Fig. 6 relates the various factors controlling the effective depth of penetration.

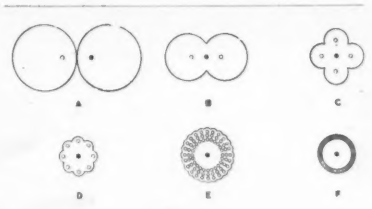

Fig. 8.

Solid Wall Shielded Transmission Line

Fig. 7 is an enlarged cross-sectional view of a solid wall shielded transmission line showing the exponential distribution of current density in the inner and outer conductors. The drawing is, of course, not to scale and only for illustration purposes. The spectrum scale at the bottom of the figure is a greatly enlarged radial cross section of the outer shielding wall showing the logarithmic decrease of current density from the inner surface to the outer surface. The scale represents current distribution in a copper wall 10 mils. in thickness for a frequency of approximately 1.4 megacycles where the outer surface current has been reduced to 1 per cent of the inner surface current. The effective depth of penetration where the current has decreased to approximately 37 per cent of the initial surface value is indicated.

There is another useful concept by which the shielding effect of a coaxial line can be explained. In Fig. 8, several sketches are shown developing the two-wire open transmission line through several stages until it approaches a solid walled tube concentric with an inner conductor. In this series of figures the instantaneous positive conductor is shown as a dot and the negative as a circle. The shape and intensity of the magnetic fields illustrated are only approximate. Fig. 8A shows a two-wire line with relatively close spacing. There is considerable field cancellation as shown. In Fig. 8B there are two return conductors, diametrically opposed, each sharing half of the circuit current with the resultant further reduction of exterior magnetic field. Figs. 8C and 8D show a further reduction of the exterior field when the number of return conductors are increased about the periphery. As the outer ring of conductors becomes more closely spaced, the magnetic lines of force, being in the same direction, will tend to link together forming a continuous, more or less circular, belt about the circumference of the circle. In Fig. 8E the number of periphery conductors has been increased in number and in depth. The innermost conductors, having lower reactance, carry the major portion of the current. Accordingly, the strongest countermagnetic field is set up by these inner conductors, with less and less current and weaker fields set up in those farthest removed from the center. Carried to its logical conclusion, an infinite number of return conductors distributed uniformly about the central conductor would cause the magnetic field to remain entirely inside the ring of return conductors. In fact, the depth to which a magnetic field will penetrate into such a ring depends upon the density and resistivity of the conductors and the frequency. Here we might form a concept that ties in with the effective depth of penetration in metals by stating that the more highly conductive metals behave as though they were composed of dense concentrations of conducting filaments.

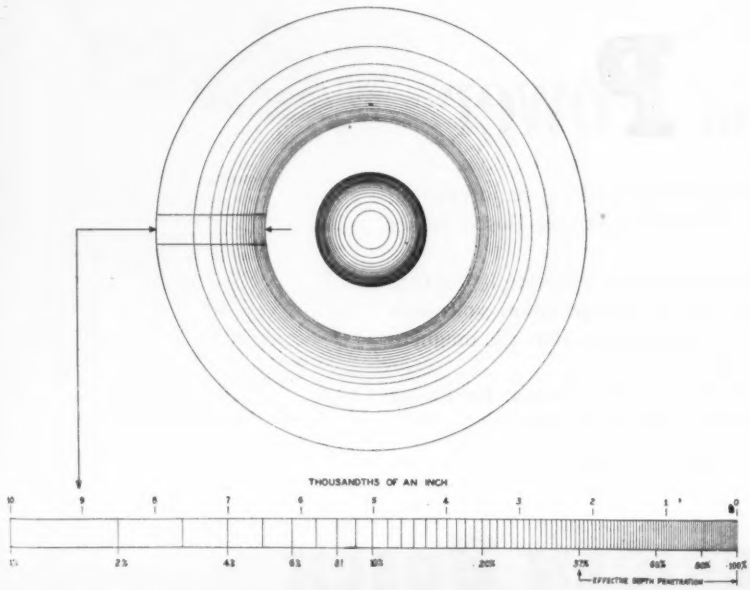

Fig. 7. Current density versus effective depth.

Consider now that a longitudinal slit of very small width is made in the outer wall of a concentric line. Such a slit will interrupt the flow of current in only a few filaments of the conductor and the conductance will not sensibly be disturbed. In addition, since the slit is at right angles to the interior magnetic lines of force, they will not tend to bulge through. The net result is that there will be an insignificant amount of leakage. On the other hand, if a transverse slit is made in the outer shielding wall, many conducting filaments will have been severed and the longitudinal current flow will be diverted around the ends of the slit. With the absence of current flow across the slit, there will be no opposing magnetic field and the magnetic lines of force from the central conductor will bulge forth through the slit since the slit is now parallel to the magnetic lines of force. Accordingly, the degree of leakage will be relatively serious. In fact, the degree of leakage will be approximately proportional to the length of the transverse slit. If the transverse slit is extended for 359° of the circumference, all of the return currents in the shield will be concentrated in one narrow bunch of conducting filaments. The resistance of this small group of conducting filaments will be considerably greater than the solid wall, with the result that a substantial potential difference will develop between the sections of the tube. This will be aggravated by the voltage drop due to the inductance of the filaments and thus the leakage will become more serious with increasing frequency.

The concept can be reversed starting with a completely severed tube. Under this condition leakage will be practically uninhibited, being reduced to a finite amount when one conducting filament is joined across the gap. If now a second filament is joined across the gap 180° removed from the first, there will be one-half the current in each path resulting in a 50 per cent reduction of the leakage. If two more conducting filaments are joined, making 90° intervals, the leakage will again be reduced one-half. Continuing this process until all filaments are joined together, the leakage will fall to that amount normal to the depth of penetration in the material of which the shield is made. If the thickness of the wall is now doubled, the shielding effectiveness will be doubled. That is to say, if the shielding effectiveness for a given thickness is 10 db., it will be 20 db. for twice the thickness. The fact that transmission loss computed in decibels is linear with respect to thickness is due to the fact that both current distribution and decibels are logarithmic functions. It should be pointed out that this is only the transmission loss and does not include reflection loss. The latter has been neglected for simplicity of explanation and for further treatment of the sub-

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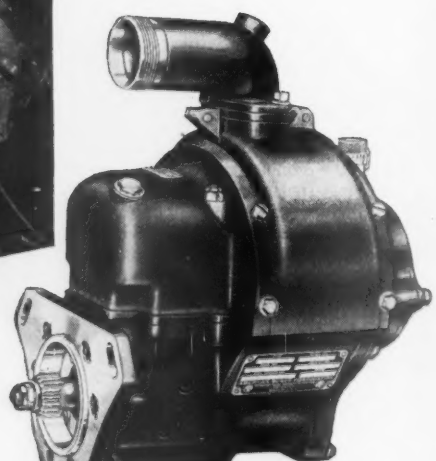

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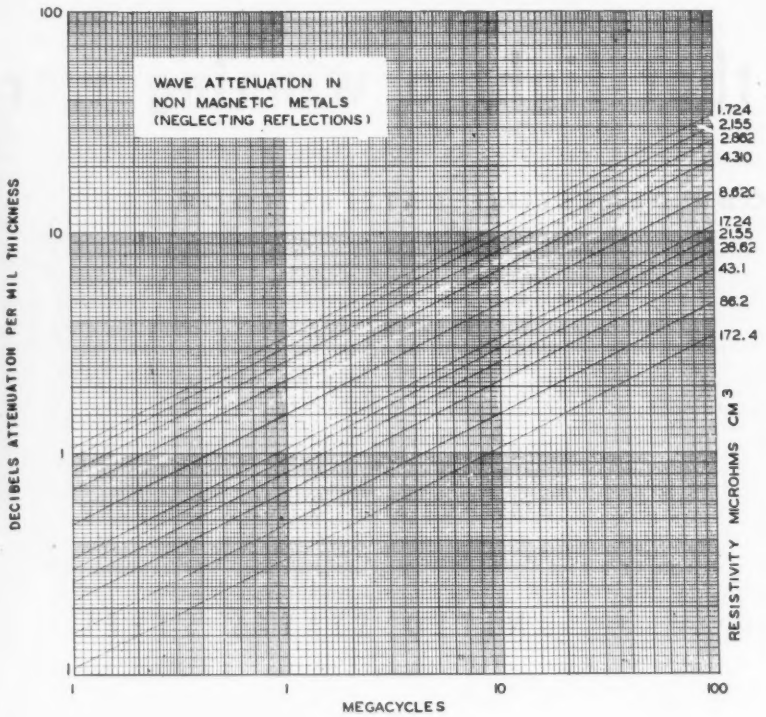

Fig. 9.

ject the reader is referred to Schelkunoff's excellent book.[1] It is sufficient to say that reflection loss will add further attenuation depending to a large extent upon the geometry of the shield and the absorption of the metal. By aid of the graph of Fig. 9, the decibels of attenuation can be quickly computed for any thickness of metal when the resistivity and frequency are given.

Shielding Joints

While the theory and concepts have been developed for a concentric transmission line, the same application may be made for magneto and distributor covers. Here it is found that doubling the number of flange screws (by halving the spacing) results in reducing the leakage by one-half. It is quickly seen that, where the minimum of leakage is desired, the spacing of the screws becomes a limiting factor. The conclusion is reached that the only complete solution is to have continuous line contact at all points and cover flanges. The width of the contact should be that amount necessary to satisfy the permissible depth of penetration for the type of metal employed. For metals such as magnesium, aluminum, and brass, the width of the required contact is in the order of a few thousandths of an inch.

Recalling that the maximum interference from the ignition system is in the V.H.F. range and that joint leakage increases with frequency, it becomes apparent that the problem of joints in shielding is far more serious than the leakage due to penetration. This is further aggravated by the fact that the conduits become fairly efficient radiators at very high frequencies, once exterior surface currents have been set up. It is, therefore, of utmost importance that joints be made completely tight and in such a manner that they will remain so for a long time. One of the most noticeable faults in current design of bolted flange construction is the lack of stiffness. This results in bowing of the surface between the points where bolt pressure is applied. Thermal effects should also be considered. Instances have been reported of ignition systems that were quiet when tested on the ground but were quite noisy in flight, especially in cold weather.

When the flange area is large the pressure per unit area is low and the metals do not mesh into one another in the manner required for perfect contact. The unit pressure must be high to break down resistance films, such as corrosion products, oil, and dirt. For joining tubular members, it has been found that a spherical section forced into a steep angle conical seat yields excellent results. The width of the line contact in such an assembly is usually sufficient to meet the shielding requirements. For larger joints, such as covers, it appears that the best solution is to make them circular in design since, by lathe operations, it is relatively easy to turn out true geometric shapes having true planes. Taper designs should also be considered as a means of multiplying screw pressure.

It should be pointed out that, although the current density decreases exponentially with wall thickness, nevertheless the actual exterior surface current varies in direct proportion to the current on the inside surface. The heaviest shielding is, therefore, required at those points in the system where the interior surface currents are the most concentrated. Similarly, the joint problem is most severe where the joint is in series with a heavy current flow. For example, the problem of making a satisfactory joint around a distributor cover is a great deal more difficult when the ignition manifold is attached to the cover, since the interior surface currents of the manifold will flow across the cover flange mating surfaces.

There is a popular misconception that leakage at joints and parting surfaces can be prevented by employing stepped construction or overlapping aprons in much the same way that light rays are trapped. Such constructions do no good by themselves, since radio-frequency currents will follow the surface no matter how much it is serrated. However, there is one special type of construction which will permit openings to be made in the shield without leakage. For want of a better name, the construction is called an attenuating wave guide. This may consist of a metal duct of cylindric or other type of cross section, one end of which is fastened electrically tight to the shield at the point of opening. The length of the duct should be several times its maximum cross section. Small metal tubes or ducts having lengths several times their maximum cross-sectional dimension will not transmit wave lengths higher than a few centimeters. In fact, wave guides will transmit radio energy only under certain critical conditions. Attenuating wave guides can be usefully employed in ignition systems where ventilation is desired.

Gaskets

While to a large extent the design of joints can be improved to obtain metal-to-metal contact, there are times when the difficulty seems almost insurmountable. The use of shielding has grown to include the elimination of moisture and, in some cases, retention of air pressure. Accordingly, the joints in an ignition system must be hydraulically correct as well as satisfying the needs of good shielding. The use of common gasket materials will not provide for the shielding purpose, and, if gaskets must be used, it is necessary that they be electrically conductive.

Gasket Materials

Early experimenters tried gaskets impregnated with graphite and rubber compounds loaded with carbon. It was soon discovered that these did not have sufficient conductivity. A gasket must not only provide uninterrupted contact between the mating surfaces but it must also have the required degree of conductivity for a suitable shielding wall. The specific resistivity of carbon is so high that a very great thickness would be required to satisfy depth of penetration considerations.

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copper, or brass, will much more readily satisfy the shielding requirements. There is, of course, the problem of preventing corrosion of bare metal surfaces, especially when dissimilar metals are present. However, experience to date has shown that this is not a serious problem and has caused little trouble, even when no protective measures were taken. The use of a heavy noncorrosive grease, with possibly an inhibitor added, will give the surfaces the necessary protection for a long period of time. An even better substance is Dow-Corning DC-4 compound. This is not only an excellent water repellent but, in addition, has constant viscosity over an extremely wide range of temperatures. When such a coating is used there is very little danger of any corrosion taking place between service overhauls, at which time the surfaces should be cleaned and recoated.

Corrosion Effects

Microscopic corrosion films, such as aluminum oxide, are highly resistant and can seriously interfere with contact, thus causing leakage. In a gasketed joint this is a serious problem since there are twice as many contact surfaces as in a metal-to-metal joint. For this reason aluminum seems to be a poor choice for a gasket material. The contact pressure requirements for gaskets are the same as for metal-to-metal joints and the same principles hold true, that is, a continuous line contact should be established with high unit pressure uniformly distributed around the joint. Concentration of the pressure on a narrow line of contact helps to insure that the gasket will be compressed into conformance with the mating surface and thus make for air and water tightness as well. Much greater success may be anticipated when a gasket and the mating surfaces are deliberately designed for optimum conditions, whereas attempts to design a gasket as a makeshift may be a complete failure.

The requirements of a good gasket may be summarized as follows:

(a) It should be made of a highly conducting metal, the thickness of which is great enough to satisfy the depth of penetration requirements.
(b) It should be designed for a narrow line of contact and high unit pressure.
(c) It should have a high degree of resilience and the ability to conform to the mating surfaces.
(d) It should be airtight and watertight.

Multiple Point Contact Gaskets

Several types of gaskets which might be classified as multiple-point contact gaskets have been developed. One of these consists of a metal screen impregnated with neoprene to make it oil- and watertight. The excess neoprene is buffed off to expose the screen. Another type consists of a neoprene core around which is wound a wire. In these types of gaskets it has been found that the shielding effectiveness is related to the fineness of screen mesh and to the closeness with which the wire is wound. The metal screen type of gasket has the disadvantage that a wide flange is required before the conductance can approach that of a narrow sheet of low resistivity metal. In effect, it can be compared to a strip of high resistivity metal since the resistivity per square centimeter is considerably greater than for a solid sheet of the same thickness. In other words, it requires a large area of exposure to obtain the same number of conducting filaments. The wire-wound neoprene core is limited in exactly the same way.

One of the most successful gaskets yet devised consists of a neoprene core over which is woven a braid of fine copper wire. This material is placed in a shallow groove and compressed between the mating surfaces. A better construction is to lay the gasket material in a deep groove into which a tongue from the opposing surface is forced. The success of this type of gasket apparently lies in the high degree of conformance obtained and the roughness or bite with which the braid establishes contact. The wires in the braid are forced into contact with each other, forming an almost uninterrupted path for the flow of current. The chief objection to this type of gasket is that it is not completely water- and airtight, although very good results have been obtained.

More specific data on the performance of various gasket materials are not yet available but the subject is one that can be readily pursued in a scientific manner.

Shielding Effectiveness of Flexible Shielding Conduit

Investigation has disclosed that there is considerable variation in the degree to which various types of flexible shielded conduit are penetrated by the radio-frequency energy generated in the ignition system. The leakage is most evident in the range below 20 megacycles. It is apparent that flexible shielded conduit, which depends largely on wire braid for the shielding wall, is relatively porous as compared to metal tubing. It seems obvious, and in fact is true, that for the same weight and type of metal a seamless metallic tube has greater shielding effectiveness than an all-braid tube.

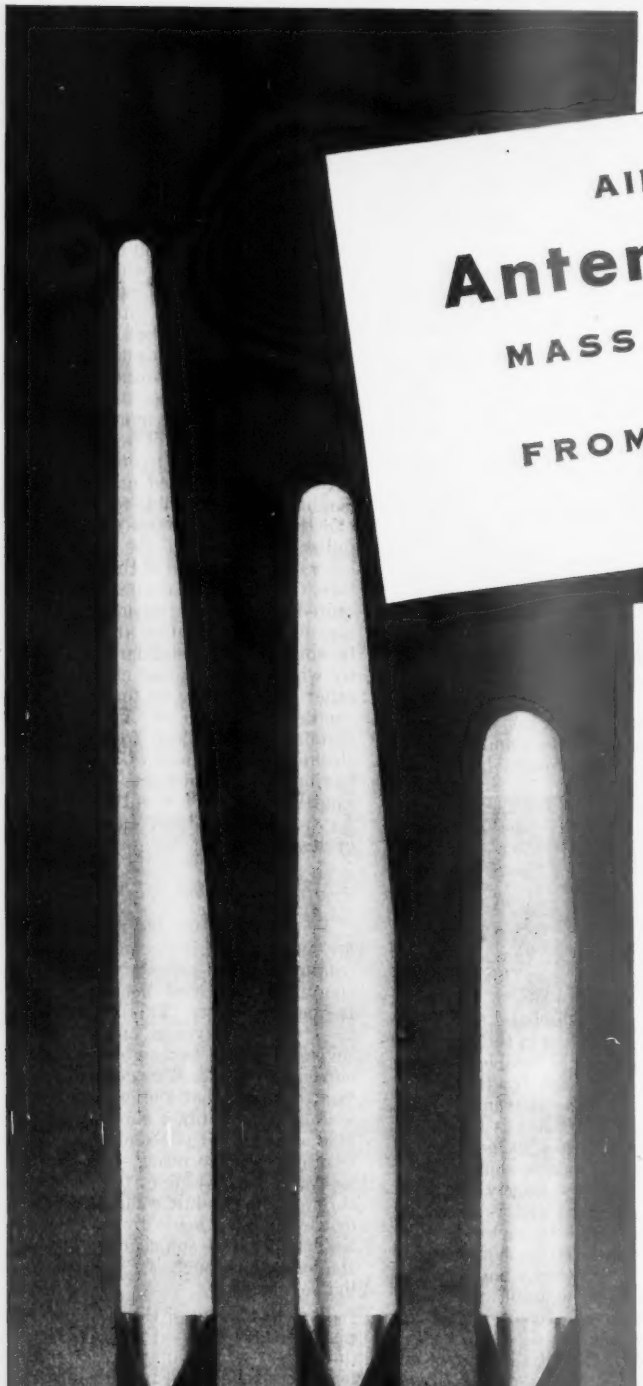
Metal hose used as the former of all flexible conduit is of two types of construction, one being made of strip brass formed into a spiral bellows and soldered in the seam, the other made of stainless steel or aluminum strip formed into a spiral which is interlocked to provide a sliding action between turns. The shielding effectiveness of such material is governed by the thickness of the metal, its conductivity, and the "electrical tightness" of its construction. In the case of the soldered seam brass hose, it would at first appear that the thickness of the brass would be the governing factor since the seams are soldered and are therefore electrically tight. However, since the conductivity of solder is much less than brass, the shielding effectiveness is greatly reduced. In interlocked hose construction the shielding effectiveness is governed by the conductivity of the metal employed and the degree of "electrical tightness" that can be obtained in the interlock.

When a radio-frequency current flows in a shielded concentric line the interior surface of the shield will have a voltage drop per unit length which is proportional, among other things, to the flow of current on the interior surface. Within the metal of the shield the voltage drop per unit length will become less and less, progressing from maximum at the interior surface to a minimum at the exterior surface. The more effective the shield, the smaller will be the potential drop per unit length on the exterior surface. When tested under the same conditions, it is possible to compare the effectiveness of the two shielding conduits by measuring the voltage drop across a given length of the exterior surface. If one of the conduits has the required amount of shielding effectiveness for the application at hand, it may be employed as a standard of reference by which the shielding effectiveness of other samples may be found. For the conduit shielding of aircraft engine systems, it has been found that the shielding effectiveness of a copper tube having a wall thickness of ten thousandths of an inch is entirely adequate for frequencies higher than 0.2 megacycle.

Testing for Shielding Effectiveness

To set up a suitable testing system for comparing shielding effectiveness of conduits, it is necessary to have a thoroughly shielded source of radio-frequency power. This source should be able to deliver a current that is several hundred times greater than the current encountered in normal application, in order that the exterior surface voltage drop will be a substantial, readable amount. It is essential, of course, that there be no other source of leakage except that due to penetration through the conduit wall. A check for leakage can be made by using a thick wall copper tube sufficient to attenuate the leakage through the wall to a negligible amount.

The test results that follow were made with 24-in. lengths of flexible conduit that were compared to 24-in. lengths of solid copper tubing of various wall thicknesses. Two different sources of radio-frequency power were used. The first was a magneto contained in a shielding can with an electric motor drive external to the shield. The drive shaft was of plastic material and entered the shielding can through an attenuating wave guide. A high voltage capacitor of 0.0125 μf was connected across the high voltage output of the magneto. This raised the apparent radio-frequency output considerably. A shielded spark gap was used to terminate the line. The voltage developed across the shielding was measured with



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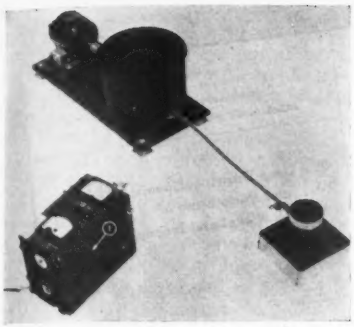


Fig. 10. Conduit shielding test apparatus, 1 Ferris 32A noise meter.

a Ferris Model No. 32A noise meter. The arrangement of the apparatus is shown in Fig. 10.

The test results shown in the two graphs that follow were obtained by the magneto/spark gap method. Fig. 11 shows the microvolts drop versus frequency for four copper tubes with wall thickness as noted. It will be seen that the curves are fairly smooth as compared with those that follow on samples of flexible conduit. The shape of the curve is determined primarily by the depth of penetration which varies inversely as the square root of frequency. However, a resistance hump at 5 megacycles will be noticed in all of the magneto/spark gap tests. This is due to a resonant condition caused by the high voltage secondary condenser.

The next series of tests were made on five samples of flexible shielding conduit as shown in Fig. 12. Sample No. 1 consists of an interlocked aluminum metal hose covered with a fine wire aluminum braid. Sample No. 2 consists of a spiral brass bellows soldered in the seam and covered with a relatively open braid of copper wire woven in the one over and one under manner. Sample No. 3 consists of a spiral brass bellows soldered in the seam with a first layer of flat strip copper braid and an outer layer of finely woven copper braid woven in the two over and two under manner. Sample No. 4 consists of a spiral brass bellows soldered in the seam with a first layer of tightly woven flat copper strip braid and an outer layer of tightly woven copper braid made in the one over and one under manner. Sample No. 5 consists of a stainless steel interlocked metal hose with a first layer of tightly woven copper braid, a layer of insulating material and a second layer of tightly woven copper braid with an outer covering of molded neoprene. For reference purposes, the curve of a copper tube having a wall thickness of 0.0106 in. is shown with a dotted line. These curves illustrate the wide differences of shielding effectiveness for different types of conduit construction.

There are two principal difficulties in using the magneto as a source of radio-frequency power for these tests. The first is the small amount of equivalent radio-frequency current with resultant small potential drop across the better

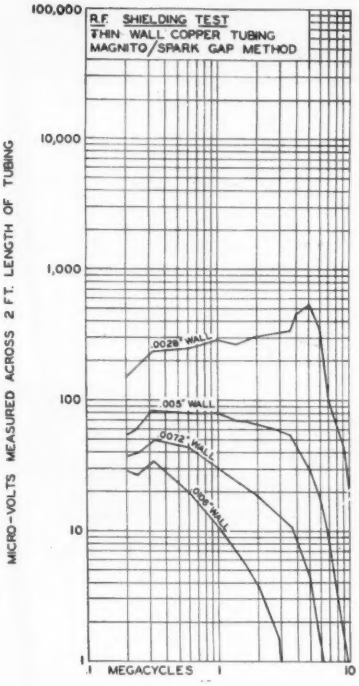


Fig. 11.

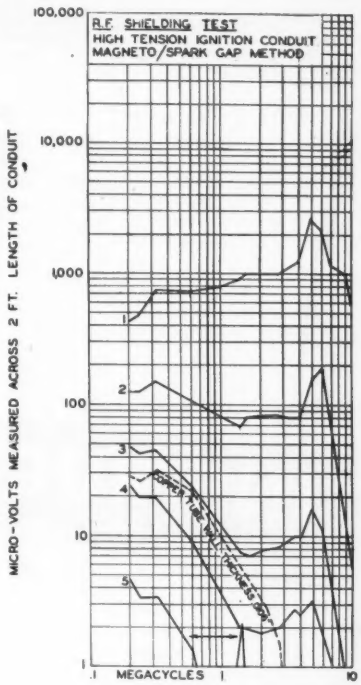


Fig. 12.

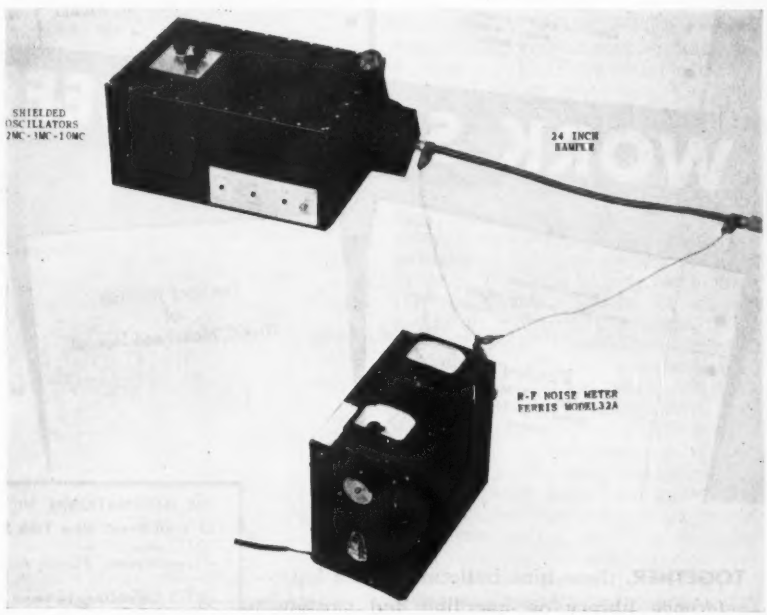
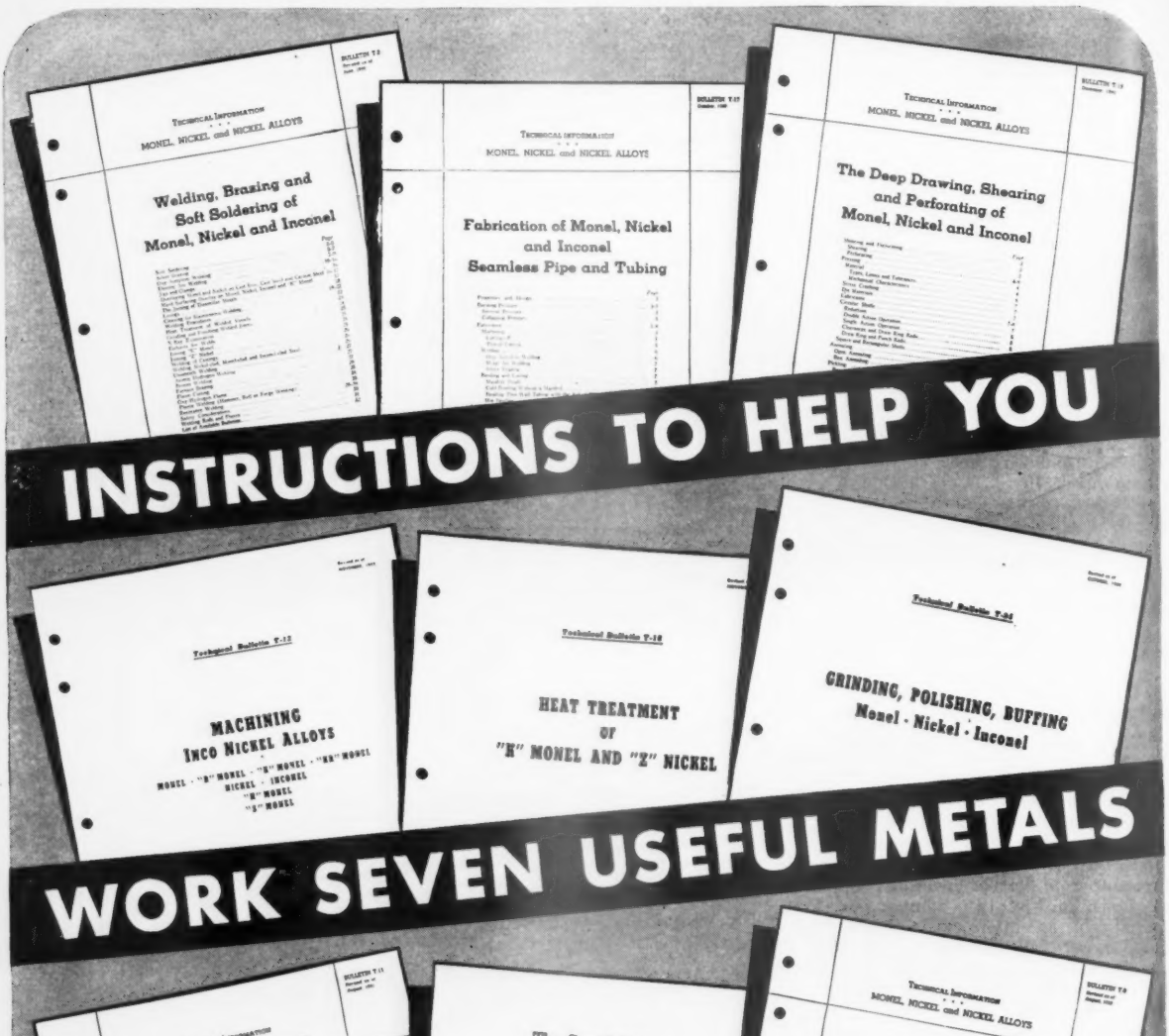


Fig. 13. Conduit shielding test using oscillator and Ferris 32A noise meter.

samples of shielding. The second difficulty is that the current output at any given frequency is unknown. Since the exterior surface potential of the shield is directly related to the current flowing in the central wire, it is desirable that the current should be maintained constant for various frequencies of test. With limited time and man power, a tunable signal generator having a high current output could not be built. From the test data taken by the magneto/spark gap method, it was concluded that some valuable information could be obtained with three fixed frequencies of 0.2, 3, and 10 megacycles. A simple well-shielded oscillator was built as shown in Fig. 13. Three separate oscillators with a switching arrangement were incorporated. These were contained in a double shielded box with the inner shield divided into compartments. An interior and an exterior filter were required to reduce the power



TOGETHER, these nine bulletins form a basic reference library on handling and working seven metals that can be readily fabricated into any desired shape or size—the INCO Nickel Alloys.

If you're working with Nickel, Monel, Inconel, or any other high-Nickel alloy, you'll find these bulletins helpful. Look over the list. Use the handy coupon to check off those that will help you in your daily work. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Gentlemen: Please mail me the bulletins I have checked below.

- ☐ T-2 "Welding, Brazing and Soft Soldering of Monel, Nickel, Inconel"
- ☐ T-17 "Fabrication of Monel, Nickel, Inconel Seamless Pipe and Tubing"
- ☐ T-19 "Deep Drawing, Shearing & Perforating of Monel, Nickel & Inconel"
- ☐ T-12 "Machining INCO Nickel Alloys"
- ☐ T-16 "Heat Treatment of "K" Monel and "Z" Nickel"
- ☐ T-24 "Grinding, Polishing, Buffing Monel, Nickel, Inconel"
- ☐ T-11 "Forging Monel, Nickel, "K" Monel, "Z" Nickel, Inconel"
- ☐ "The Spot Welding of Nickel, Monel and Inconel"
- ☐ T-9 "Engineering Properties of "K" Monel"

Name.....

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Company.....

Address.....

A.E.R. 8-45

City.....*Zone*.....*State*.....

cord leakage to a negligible amount. A radio-frequency ammeter, used to read the line current, was contained in a thoroughly shielded box with an attenuating wave guide over the face of the meter to prevent leakage.

A Ferris Model 32A noise meter, which had been directly calibrated against a standard signal generator, was used to read the microvolts drop across the length of conduit. Obviously, any suitable receiver could be modified for the same purpose. No modulation was employed in the oscillator or the standard signal generator.

Fig. 14 shows the results of tests on the same four samples of thin wall copper tubing using the oscillator method. The tubes were made of oxygen-free copper having a resistivity of 1.724×10^{-6}. The line current was 0.9 amp. unmodulated radio frequency with three test frequencies of 0.2, 3, and 10 megacycles.

Fig. 15 shows the results of tests made in a similar manner on the five samples of flexible conduit. In comparison with the same tests for copper tubes, the most noticeable difference is in the lower rate of decline in the high frequencies. Sample No. 1 is the aluminum conduit which shows a substantial rise in leakage with increasing frequency. Indications are that the radio-frequency resistance of the conduit rises with frequency, behaving in a manner as though the resistivity of the metal increased with frequency. Actually, it was necessary to increase the oscillator power output to maintain constant line current at the higher frequencies for samples 1 and 5.

It is of interest to note the relatively lower standing of conduit No. 5, which, in the magneto/spark gap method of test, had superior shielding qualities. The reason for this is not clear at this time. It is thought that the magnetic stainless steel interlocked hose used in this product has peculiar damping characteristics that make it very effective in reducing the amplitude of oscillations such as those created by the magneto and spark gap. In general, the rising characteristic of samples 1 and 5 at the higher frequency and the failure of all samples to fall off as rapidly as the copper tubes indicate that the radio-frequency resistance of the braid becomes pronounced in this frequency range.

Tests have been made on the shielding effectiveness of the hose and braids of which most conduits are made, to determine which contributes most to the shielding quality. In general, the metal hose contributes the smaller part showing a leakage of from ten to 1,000 times that of a tight layer of copper braid. Soldered seam hose is generally superior to interlocked hose.

The results of this study leave much to be desired in a knowledge of the behavior at frequencies higher than 10 megacycles. Further investigation awaits the construction of suitable oscillator equipment. It is known from probe tests on complete ignition systems that there is rarely any penetration

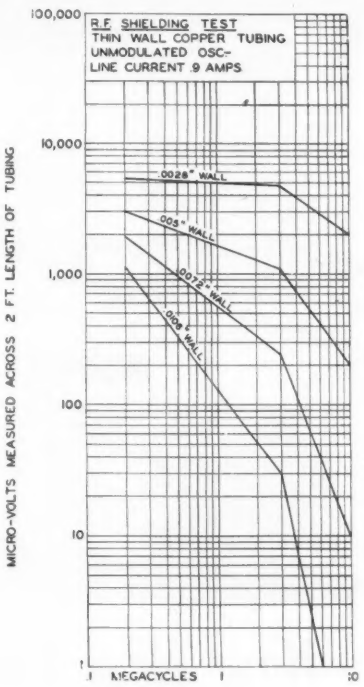


Fig. 14.

leakage at the higher frequencies. Apparently the skin effect predominates to such an extent that the resistivity of the braid is sufficiently low for good shielding at these frequencies.

At the present time a great deal of research on the factors controlling the shielding effectiveness of flexible shielding conduit is being done by several manufacturers. Factors of braid design and the effect of contact resistance between wires of the braid are being closely studied. Magnetic metals are also being investigated. Some experimental samples of conduit show remarkable shielding effectiveness for weights no greater than present conduits. Improvement of mechanical strength as a by-product is a certainty.

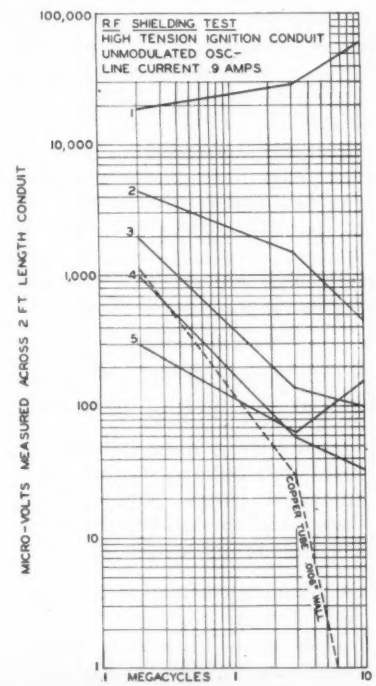
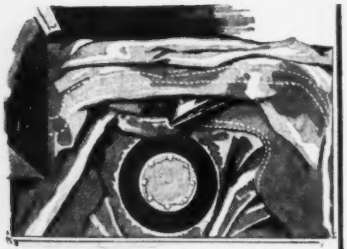


Fig. 15.

Radiation and Propagation from Poor Shielding

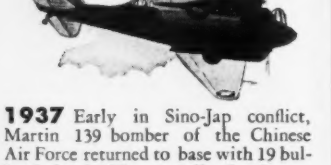
Radiation of radio waves from any circuit involves a time-space relationship. That is to say, the propagation of radio waves through space does not occur instantly but progresses at the rate of 186,000 miles per sec. If a substantial electromagnetic field is established at a distance from a circuit such that the time required for the energy to return to the circuit is greater than the time required for phase reversal of the magnetic field at the source, only a portion of the energy in the field will be returned to the circuit and the balance will be radiated into space. This implies that, for effective radiation at low frequencies, the electromagnetic field about the circuit must extend for a relatively large distance in order that there be sufficient time for the circuit field to reverse in phase before the collapsing field has been completely reabsorbed. In turn, to establish a strong magnetic field at a great distance requires a radiator of considerable dimension. At higher frequencies, the radiator becomes smaller, since the more rapid reversal of the field will find energy from relatively short distances which has not been returned to the circuit for lack of sufficient time. Radiation is then, not so much a matter of the field strength near the source, but rather the strength of the field created at some distance from the source such that there is insufficient time for all the energy to return to the circuit. The tank circuit of a transmitter may be taken as an example of a source having an intense localized electromagnetic field. Unless energy is transferred to a suitable radiation circuit, little energy escapes and the collapsing field returns practically all the energy to the circuit.

These points have been made as a basis for clarifying some of the conditions surrounding radiation of noise from improperly shielded ignition systems. At first glance, it would appear that the suitability of a shielding system might be tested by making radiation field strength tests about an engine in an airplane but, since the radiation field will be considerably distorted in almost unpredictable ways by the surrounding metallic structure of the particular airplane in which it is installed, the test will reflect the noise condition of the engine for only one particular set of conditions. Furthermore, some leakage fields, which of themselves are quite localized and poorly radiated, may be transferred by inductance to nearby structural members of the particular airplane and quite effectively radiated. Accordingly, if one were to devise a test for evaluating

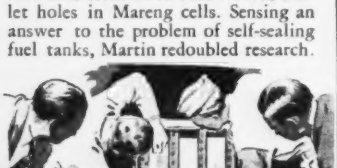


1936 First Mareng cell was aircraft fuel tank. If damaged, it could be pulled through opening, a new cell inserted like the bladder of a football. No need to remove wing, as with a metal fuel tank, thus simplifying maintenance.

1937 Early in Sino-Jap conflict, Martin 139 bomber of the Chinese Air Force returned to base with 19 bullet holes in Mareng cells. Sensing an answer to the problem of self-sealing fuel tanks, Martin redoubled research.



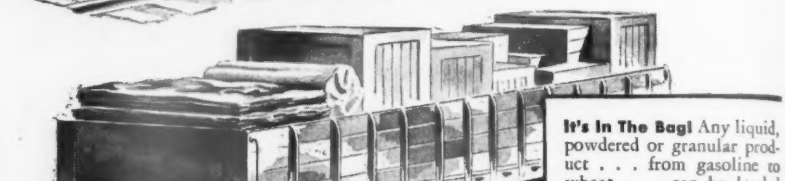
1940 Army Air Forces proclaimed self-sealing tanks a "must," Martin was first to respond. Martin engineers had been working on problem since 1919 tested 285 materials. Above, Martin self-sealing tank, riddled with bullets.



1942 "Jimmy" Doolittle makes first U. S. raid on Tokyo, his bombers given the needed range by special Mareng cells designed by Martin. Above, Mareng cell in B-25 of type used by Doolittle in his historic flight.

1945 Armored columns racing across Germany used big storage-type Mareng cells to set up fuel depots. Other storage cells, containing as much as 10,000 gallons, are quickly set up on captured Jap airbases to fuel our warplanes.

If It Pours, Mareng cells can carry it. Reaching destination, cells are emptied, folded into compact bundles, sent back to shipper. Space and weight saved permits other goods to travel in same car. Result: lower shipping costs.



It's In The Bag! Any liquid, powdered or granular product . . . from gasoline to wheat . . . can be loaded quickly, easily. Tough, elastic Mareng cells may be made in any size, any shape, may also be used for storage.

How New Elastic Container May Cut Shipping Costs of

liquids, powders, grains . . anything that pours!

AN entirely new type of container . . . which promises substantial savings in the handling and shipping of liquid, powdered, granular or other free-flowing materials . . . is rapidly becoming one of the most talked-of postwar products yet to emerge from Martin laboratories. These containers —known as Mareng cells from the first syllables of the words "Martin Engineering"—are, basically, huge elastic "bags." Designed originally as fuel tanks for aircraft, they have made vital contribution to the Allied war effort (see pictures at left) . . . hold equally high promise as a means of transporting peacetime products.

Many Advantages

Here are some of the advantages offered by the Martin Mareng cells:

1 In just a few minutes cells may be fitted into ordinary railway cars, trucks or barges, thus enabling these vehicles to carry liquid or free-flowing dry materials.

2 On reaching destination and emptied of their contents, cells are folded up and shipped to sender. One boxcar will hold enough empty cells to load six boxcars when cells are filled. This cuts round-trip shipping costs, eliminates haulage of empty tank cars or tank trucks.

3 Cells cannot be bent or dented, will not rust or corrode, yield under impact instead of breaking, are lighter and easier to handle.

4 If punctured, Mareng cells may be quickly patched, thus avoiding soldering or other time-consuming repairs required to patch metal containers.

We Welcome Suggestions

Busy with wartime production of Martin Mars, Mariner and other aircraft, the Glenn L. Martin Company has been unable to explore fully the peacetime uses of the Mareng cell. If you see possibilities for these elastic containers in your business or in other fields, we welcome your suggestions. Address, THE GLENN L. MARTIN CO., BALTIMORE 3, MARYLAND.

The Glenn L. Martin-Nebraska Company—Omaha

Martin
AIRCRAFT
Builders of Dependable Aircraft Since 1909

shielding effectiveness, it would appear logical that there should be an extremely low leakage magnetic field at any point about the shielding, since under this condition there would be little likelihood of radiation from any cause.

The effect of joint leakage is to cause exterior surface currents to flow. Likewise, exterior surface currents exist where insufficient shielding thickness permits penetration of an appreciable amount of current. The degree to which magnetic fields set up by such surface currents are radiated will depend upon the strength of such fields at a distance from the shield which is large in relation to frequency.

Considering the engine only, without relation to the structure in which it is installed, the most effective radiators will be the flexible spark-plug conduits and the ignition manifold. Since these are all grounded at various points, the radiators are essentially closed loops. In this type of radiator, the efficiency is related to the amount of enclosed space which, for a given length of conduction path, would be a maximum for a circle. When the conducting path is everywhere close to the body of the engine, the radiation effectiveness is greatly decreased and will be still further reduced if low impedance grounding bonds are placed at frequent intervals along the circuit. The effect of bonds is to break up the larger loop into many smaller loops with less current in each loop as the number of bonds are increased. The difficulties with bonding are in obtaining a sufficient number of low impedance bonds well distributed along the length of the conduit. An ideal bonding system would have an infinite number of bonds of practically zero impedance. If such a conduit had a transverse slit, the escaping magnetic field would be small and all the energy returned to the circuit. If the entire ignition system were to be submerged in the ground plane of the engine, there would be little effective radiation in spite of some leakage of magnetic fields. The principal danger is that some energy would likely be transferred from leakage fields to nearby structural members, which would act as radiators.

Nothing in the foregoing is intended to imply that free radiation is a prerequisite for interference with installed aircraft radio equipment. In fact, both the radiation field and induction field are reflected and conducted about the airplane structure to such an extent that it is difficult to say whether the energy intercepted is from the radiation or induction fields.

Two peculiar noise conditions in aircraft engines are worth special mention. One is the leakage field frequently found at the base mounting of magnetos. This is caused by the fact that the magneto drive shaft acquires a high radio-frequency potential from within the magneto and, since an oil film effectively insulates the shaft from its bearing, this potential difference is exerted between the magneto flange and the engine body. The current set up by this potential flows across the mating surfaces of the flange and the mounting boss. If an insulating gasket is used at this point, there will be a leakage magnetic field. The magneto should have a continuous line contact between the mounting flange and boss.

The second condition is found in two different makes of in-line engines having distributors driven by the valve cam shaft. It has been found that radio-frequency potentials acquired by the cam shaft from within the distributor housing are communicated along the cam shaft causing currents to flow in the cam shaft and thence through the counter drive shaft into the crankcase. In both instances, the counter drive shaft passes from the head of the cylinder block to the crankcase through an exterior sleeve that is insulated at both ends by gaskets. Radiation from the insulated metallic sleeve is quite noticeable in the very high frequency range.

Practical Testing Methods

To determine that the shielding of an ignition system is adequate, it is merely necessary to employ a highly sensitive receiver to test for the presence of exterior fields at points close to the ignition system. With well-designed shielding, there should be little or no detectable external field.

To quote from Schelkunoff,[1] "Since, in practice, high shielding efficiencies are required one is not justified in looking for exact solutions, especially as such solutions show that in general no shield has a single figure of merit, independent of the position of the point at which the shielding efficiency is measured." This highlights the important fact that neither the computation of shielding effectiveness nor the measurement of the leakage field requires exacting treatment. All that is necessary is that the shielding provide an adequate degree of attenuation.

This is readily accomplished with an extremely small amount of metal. Practical tests indicate that a shielding wall of copper ten thousandths of an inch in thickness will provide a safe margin of shielding effectiveness for frequencies as low as 0.2 megacycle. For higher frequencies the shielding effectiveness improves as the square root of frequency. From this it is seen that the shielding effectiveness for very high frequencies is many times greater than that actually required.

The best test method found thus far has been to employ the most sensitive receivers available with an electrostatically shielded probe coil as shown in Fig. 16. In the wiring of the probe, it should be noted that the ground is brought back to the connecting plug. This is done because most receivers have grounded antenna coils and a ground at this point prevents common impedance coupling to currents flowing in the shield of the flexible conductor.

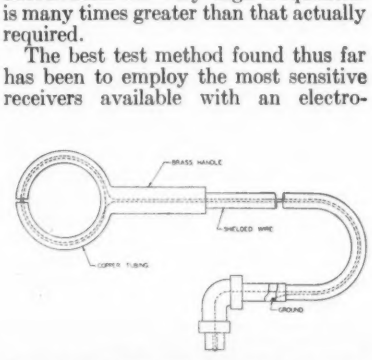


Fig. 16. Electrostatically shielded radio noise probe.

Two models of shielded probe coils have been widely used. The smaller probe has a 1-in. mean diameter with one turn of wire, and the larger probe has a 3-in. mean diameter with two turns of wire. The larger probe is generally more sensitive at the lower frequencies but the smaller probe has advantages in accessibility in cramped places about the engine. The smaller probe has been found more sensitive in the higher regions of the V.H.F. range.

These probes have been extensively used in testing engines in operation, but the dangers and discomforts of such work are obvious. A better study method is shown in Fig. 17 in which an engine is arranged with an electric motor driving only the ignition mechanism and necessary oiling system. The only dissimilarity in this type of operation, as compared with actual operation of the engine, is the absence of compression. It is known that the breakdown voltage for spark plugs increases with compression and it has been observed that radio-frequency disturbances are greater when the compression is greater. Several tests made with arrangements for pressurizing the spark chambers have shown that the increase of radio-frequency noise is approximately two to one from atmospheric pressure to 150 lbs. of pressure. For simplicity it is probably just as well to use standard spark plugs with standard gap clearances and a multiplying factor of two for all readings obtained. The difference becomes insignificant at the vanishing point which is the objective in all good shielding.

By carefully lapping and fitting all joints in some present ignition systems it has been possible to reduce the leakage to such an extent that it was not detectable with the most sensitive receivers, using either the probe coil or antenna as a means of pickup. Obviously, such a quiet ignition system would have even less chance of affecting radio equipment as installed in an airplane. In this connection it has been found that the probe coil is several times more sensitive than an antenna. This is due to the fact that the probe coil can be placed close and in inductive relation to the leakage field.

One of the shortcomings of testing the ignition system directly is that, at the vanishing point of detection, the question arises as to whether the leakage field is barely under the threshold of detectability or substantially below. The good engineer will seek a substantial safety factor. To overcome this problem, a thoroughly shielded oscillator or group of oscillators capable of delivering approximately 1 amp. of radio-frequency current at various points in the spectrum will be found

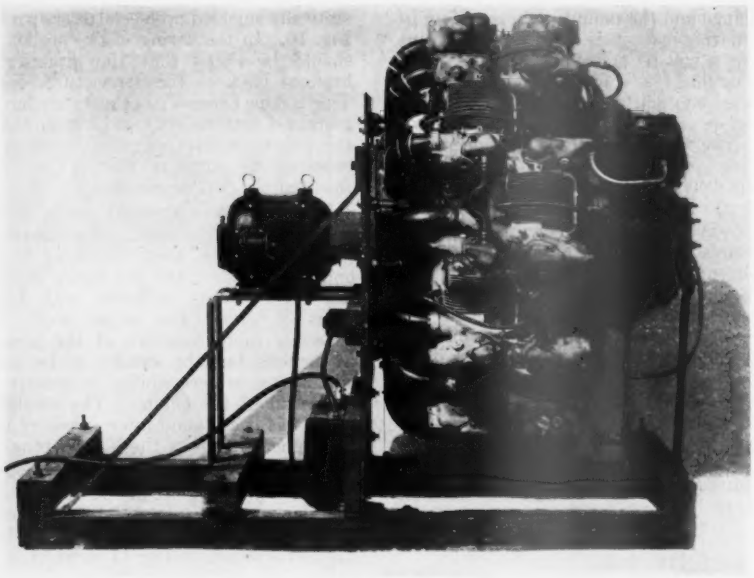


Fig. 17.

useful. A 1-amp. current is several hundred times as great as the equivalent R.F. current in the ignition system, and will cause pronounced leakage at weak points. In making a new coupling, or housing, or a new flexible conduit, the article can be studied in the laboratory independent of the complete ignition system. For example, a coupling under study can be used to join two pieces of heavy copper tubing in which a central wire carries 1 amp. of radio-frequency current. It is certain that a coupling in which the leakage can be reduced to a small amount with a low torque applied to the nut is much more satisfactory than one requiring a high torque. Similarly, manufacturing tolerances can be evaluated by averaging results from a number of samples.

The effectiveness of a cover design or a conducting gasket can be tested in the same general manner by supplying 1 amp. of current from an oscillator through a well-shielded line terminated on the inside of the cover. The manner in which flexible shielding conduit can be tested has already been covered.

In the absence of an engine, a complete ignition system can be mounted as a mock-up rig in much the same manner as though the system were mounted and operated on an engine.

Such procedures as outlined will enable the design engineer to be thoroughly certain of the shielding effectiveness of the ignition system prior to actual employment.

Conclusions

By proper employment of shielding, the radio noise from ignition systems can be suppressed well below the point of detectability. The greatest difficulty with aircraft-engine ignition shielding is due to imperfect contact in couplings and between faying surfaces of covers and mounting flanges. There must be a continuous circumscribing line of contact, the width of which is sufficient to satisfy depth of penetration considerations for the type of metal employed. Joints that are perpendicular to the direction of the current flow are most critical. Where there is lack of contact, leakage increases with frequency. Conducting gaskets can be employed to obtain better interfacial contact at flanges. The thickness of the gasket metal must be sufficient to prevent effective penetration. High unit pressure at all points around the contacting surfaces is a requirement for good contact. Direct transmission by penetration through the metallic shield is small. As little as ten-thousandths-inch thickness of copper will adequately shield the ignition system for frequencies higher than 0.2 megacycle. Resonant oscillations of the ignition circuits occur in the region above 10 megacycles, intensifying the shielding problem in the V.H.F. range. Resistance wire high-tension cable has a marked effect in damping these high-frequency oscillations. With values of 180 ohms per ft., the intensity of oscillations can be reduced approximately 17 to 1. The inclusion of a built-in filter for the magneto grounding lead would materially aid in suppressing the V.H.F. interference radiated by the magneto grounding circuit. Flexible shielding conduit does not have the same effectiveness as the equivalent weight of seamless tubing. This is attributed to the greater depth of penetration in braids, the impedance of which increases with frequency. The design engineer should employ practical testing methods for studying shielding effectiveness during design stages.

It is recognized that most concepts break down under rigorous examination. Those presented here are no exception. However, insofar as they contribute to a workable understanding, they will have served their purpose.

Reference

[1] Schelkunoff, S. A., *Electromagnetic Waves*, p. 304; D. Van Nostrand Company, Inc., New York, 1943.

Aircraft Engine Gage Unit

(*Continued from page 11*)

scale angle and scale distribution are controlled within limits by adjusting the two variable resistors shown in Fig. 14.

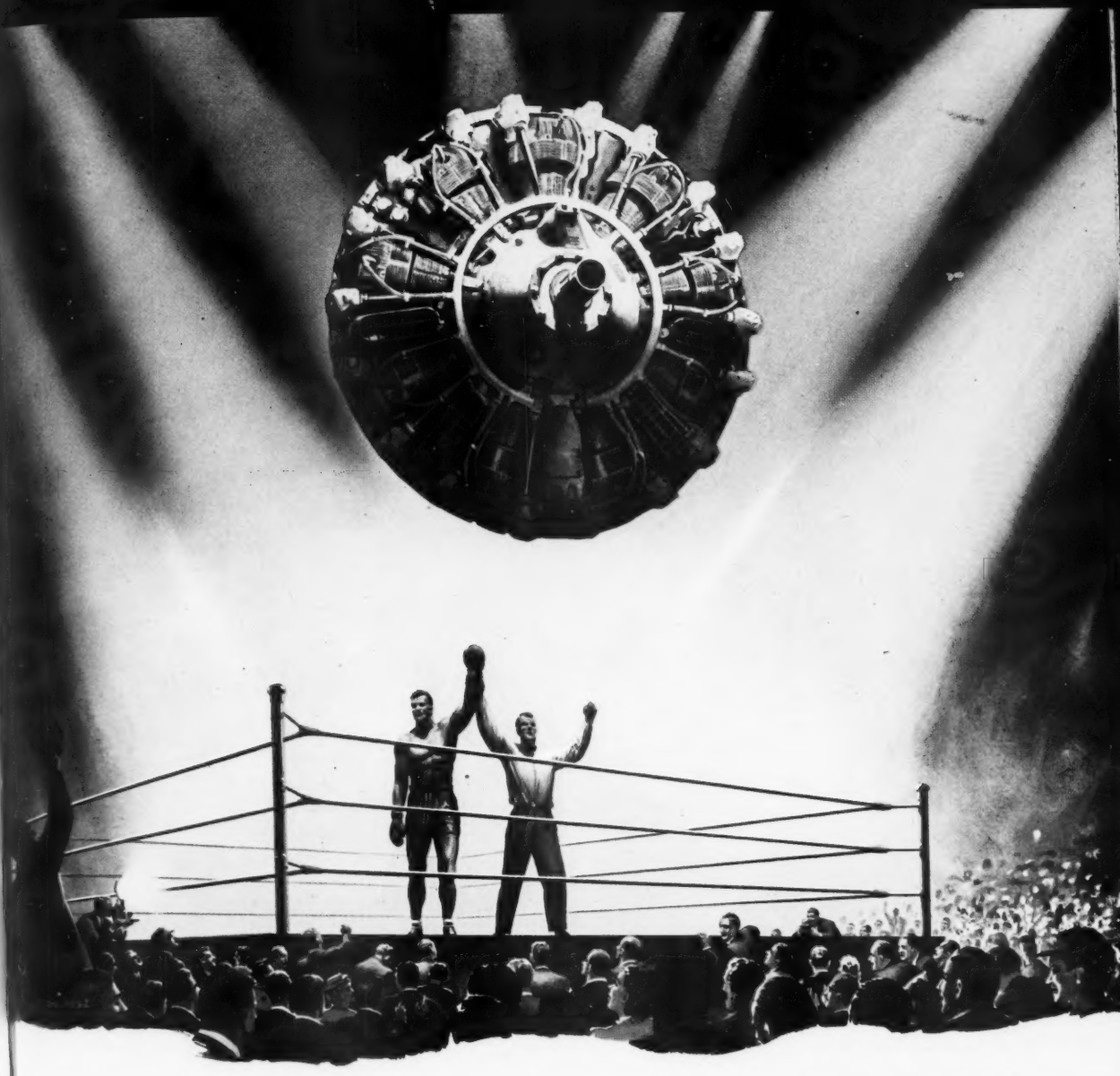
Conclusions

To the designer and manufacturer, the engine gage unit presents almost three times as many problems as a similar instrument measuring a single quantity. However, careful mechanical design has made this device practical for quantity manufacture.

Design contributions have advanced the state of the art by effecting satisfactory performance under more severe requirements of vibration, ambient temperature, and overpressure, with no increase in weight and no sacrifice of accuracy. This accomplishment is in keeping with the trend toward improved operation and simplification of the aircraft instrument panel.

The design of engine gage units will continue to develop with the progress of aircraft instrument practice. Completely electrical, remotely controlled engine gage units can be predicted for the near future. Elimination of the danger of pressure leaks, reduction in vulnerability to gunfire, decreased weight, and greater ease of installation make such an engine gage unit desirable and particularly adaptable to multi-engined planes in which it is not now commonly used. Other new features and extended scale ranges will be incorporated as requirements demand.

The engine gage unit, as an established design, is in keeping with the present trend toward multiple instruments. This trend is further illustrated by multiple speed, temperature, pressure, and position indicators, and arises from the close attention being given to the design of instrument panels. The day may not be far off when a multiple instrument and an integrated instrument panel become one and the same.



Champion - *on Every Count*

The next challenge in air transportation is to get more revenue dollars from equipment. And like the champion it is, the Cyclone 9 is ready to match its power and economy against the field.

To operators who must stay in the black to stay in business, the Cyclone 9 offers two things. First, the power and mechanical performance necessary for airline operation. Second, economy—in the form of more power per pound, more value per maintenance dollar and more miles per gallon of fuel. These qualities come from the 18 years of flight and research and refinement which have made the Cyclone 9 the most highly developed aircraft engine in the world. Only by combining this power performance with economy could the Cyclone 9 have become a major airline engine and the greatest source of power for four-engined bombers.

Now, with a sharp increase in power, and with added refinements for greater economy and improved operation, the Cyclone 9 is available for the new types of planes which will bring about true mass transportation by air.

Backbone of Business

Air transportation of tomorrow will demand many types of planes: feeder, trunk and transoceanic. Yet the backbone of the business will be the transport carrying goods and passengers short distances quickly and economically. In this field, the Cyclone 9 is unexcelled as a source of power.

WRIGHT
AIRCRAFT ENGINES

DIVISION OF
CURTISS WRIGHT
FIRST IN FLIGHT

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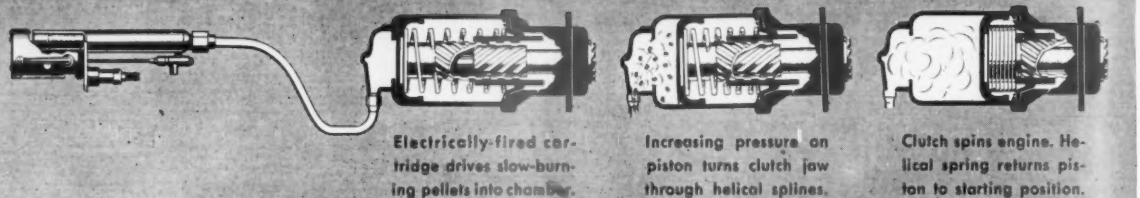
Carrier War

and the Breeze Cartridge Engine Starter

"To start the engine of an F6F fighter, you don't press the button of an automobile-type self-starter (that would be too heavy), and you don't spin the prop by hand a la World War I (no man would be strong enough to turn it). Instead you insert a little explosive charge which looks like a shot gun cartridge in a firing mechanism under the engine, then close a little door. The pilot in his cockpit simply presses an electric button, the cartridge fires like a pistol, and the resulting gust turns over the engine".

—from **CARRIER WAR**, by Lt. Oliver Jensen, U. S. N. R.
(Simon and Schuster 1945)



Electrically-fired cartridge drives slow-burning pellets into chamber.

Increasing pressure on piston turns clutch jaw through helical splines.

Clutch spins engine. Helical spring returns piston to starting position.

Manufactured under Coffman patents

● The Breeze Cartridge Engine Starter is familiar equipment on the hard-hitting carrier squadrons of the U. S. Navy. Providing a quick, dependable means of starting the most powerful aircraft engines, this starter has built up an enviable service record in all theatres of warfare. Operating on the spiral drive principle, as illustrated above, the light-weight Cartridge Starter smoothly transforms the 30-ton thrust of the fuel charge into crankshaft torque. The various models of the Cartridge Starter now in service are designed to spin into instant life engines ranging from 300 to more than 3000 horsepower.

BREEZE

Corporations Inc.

NEWARK 7 BREEZE NEW JERSEY

The Fairchild K-8 Computing Gun Sight

H. ERWIN HALE*

Fairchild Camera & Instrument Corporation

Introduction

Known by the U.S. Army as the model K-8, the Fairchild computing gun sight automatically compensates for all factors that go into making direct hits possible. The gunner keeps the reticle in the sight lined up with his target, and the deflection of the gun is corrected to compensate for all factors affecting the course of the bullet in flight, as well as to provide the necessary lead to compensate for the relative velocity of the enemy aircraft. Compensation of all ballistics factors involved is done electrically. The final voltage, representing the desired offset between the line of sight and the gun, is sent to an electronic servo system to provide the desired offset.

Fairchild Camera & Instrument Corporation began development of the K-8 in their laboratories in 1938. After the usual development difficulties and exhaustive field tests, the sight has been in production by Fairchild and in combat use by the U.S. Army Air Forces for many months.

It is not the only gun sight in its field. About 1 year after Fairchild began development of its electric air-borne gun sight, a similar development was begun in England. Apparently working independently, the British arrived at the same conclusion in their method of computation. It is in production by three United States manufacturers. In England it is known as the Mark 2, but it is designated by the U.S. Army as the K-15 and by the Navy as the Mark 18. This British air-borne gun sight, however, does not provide so complete a solution to the problems involved as the Fairchild unit.

Other air-borne gun sights are basically mechanical in operation. Some manufacturers, recognizing the advantages of electricity, use electric mechanisms in their sights.

Advantages of Electrical Computations

Prior to the development of the Fairchild K-8, it was necessary, with the mechanical systems, to eliminate some of the factors entirely and to provide only partial compensation for some of the remaining factors. But by use of an electrical system, it is possible to include all the factors that should enter into the computation. Electrical computation is also instantaneous and is of great importance when dealing with target speeds of 300 or 400 m.p.h. and bullet velocities of 2,700 ft. per sec.

There are other advantages to electrical computation. When dealing with the limited space available in aircraft turrets, use of an electrical computing system permits distribution of various components of the system wherever convenient in a turret, since only electrical wiring is required between components. This also reduces the size of the equipment in front of the gunner's face, giving him much greater visibility. Finally, electrical computation eliminates backlash and the consequent necessity of adjustment and effects of wear.

Required Compensations

Two major compensations are required of an aircraft gun sight. The first is the lead to compensate for relative velocity between target and bomber. The second is the correction for windage and gravity, known as ballistic deflection.

Lead is determined from the product of angular velocity and time of flight of the projectile. In turn, time of flight depends upon five factors: azimuth position of gun, gun elevation, range of the target, indicated air speed of the bomber, and altitude of the bomber. Although there is no exact relationship between the two, the ballistic deflection also depends upon these same five factors. Ballistic deflection is computed separately from the time of flight.

The effect of indicated air speed and altitude have had to be neglected by manufacturers of previous mechanical computers. To simplify the problem further, it has been necessary for them to use only two of the remaining factors at a time for a given computation. For example, in computing the vertical deflection, it was possible to include only azimuth position of the gun and gun elevation in a mechanical computer, with the effect of range being neglected entirely. With the Fairchild electrical computing system, all factors are included in all computations. Instead of producing only an approximation to the correct deflection, therefore, the K-8 sight produces an almost exact solution under all conditions. Scores three or four times greater than any previously recorded for mechanical computers have therefore been obtained.

Computation Method

Specially designed d.c. generators, connected to the turret and gun elevation drive, determine the angular velocity of the target. In effect, these generators are electrical tachometers, with wound fields instead of the usual permanent magnet fields. The purpose of the wound field is to provide for multiplication of the angular velocity, as indicated by the speed of the generator, by the time of flight, as indicated by the strength of the current in the field of generators. Thus it was necessary to develop generators with extremely low residual magnetism so that the linear relationship of this product could be maintained. In these generators the residual magnetism is kept under 1 per cent.

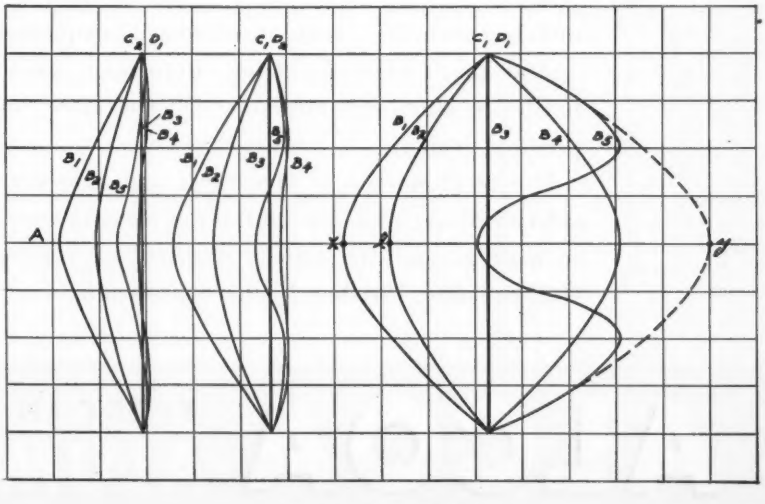


Fig. 1. Time of flight.

Presented at the National Fall Meeting, I.A.S., Dayton, Ohio, November 9–10, 1944.

* Engineer in Charge, Computer Section.

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The time of flight current is obtained from an electrical attenuator network that was especially developed by Fairchild for this purpose. Essentially, the attenuators are the same as those used in the radio industry for several years, but the accuracy requirements in this equipment are far greater than previous applications have necessitated. Problems of obtaining this accuracy and the special tapers required for the various attenuators were worked out with another concern of long experience in this field.

The attenuators, or T-pads, are used in the computing network to maintain constant circuit impedance while the attenuation, corresponding to various factors involved in the computation, is altered. Current is supplied to the various attenuator networks by specially designed permanent magnet d.c. generators.

Time of Flight Deflection

Figs. 1 and 2 show the general approach to the problem of designing an electrical computing network. Fig. 1 shows the variation of time of flight with four factors, A, B, C, and D; a fifth factor, E, is omitted for reasons of clarity. Fig. 2 shows an electrical computing network that produces a voltage varying in accordance with the curve shown in Fig. 1.

Since the relationship between various factors is so complex that it cannot be represented by mathematical formulas, the approach to this problem in the case of the gun-sight computer is purely empiric. However, electrical computing networks following exact mathematical formulas can be, and have been, built just as easily.

Fig. 1 also shows three families of curves, representing variation of time of flight of A with two conditions of C, D remaining fixed, and two conditions of D, C remaining fixed. Five conditions of B are illustrated in each family or group.

Inspection of these curves shows that time of flight does not vary with A under the condition B3. Under this condition, only factors C and D affect time of flight.

Referring to Fig. 2, generator 1 supplies a voltage proportional to the time of flight corresponding to B3 under condition C1D1. Attenuator C attenuates the voltage of generator 1 in accordance with variation of time of flight with factor C under condition B3. In series with C, attenuator D attenuates this voltage in accordance with variation of time of flight with factor D under condition B3.

Considering for the moment only condition C1D1 in Fig. 1, it is seen that, if a voltage proportional to the maximum difference between B1B3 is subtracted from the voltage corresponding to B3, the point X on B1 will be obtained. Further, the complete curve B1 can be obtained if this second voltage is then attenuated in accordance with the variation with factor A.

Another attenuator in this second circuit varies this second voltage still further in accordance with the variation of factor B. When the other two groups of curves illustrated are studied, it is seen that the difference between values B1 and B3 are less in each case than in the case of C1D1. Therefore it is also necessary to provide C and D attenuators in this second, or auxiliary, circuit.

Finally, with the attenuators thus far mentioned, a voltage proportional to time of flight for all conditions between B1 and B3 for all values of A, B, and C will be obtained.

Next, to obtain a voltage proportional to time of flight under conditions between B3 and B5, it is necessary to add a voltage corresponding to B3 under condition C1D1. In doing this, it was found that by extending the curve B5 (indicated by the dotted line) some of the attenuators, already mentioned as being used in the first auxiliary circuit, could also be used for these conditions. To accomplish this, reversing switches are provided in the auxiliary circuit, causing voltage from generator 2 to be added to that from generator 1 rather than to be subtracted as in the previous case.

Further inspection of the curve reveals that the same A and B attenuators can be used. But different C and D attenuators must be provided because, as explained under conditions C1D2, and C2D1, attenuation on the right-hand side must be much more rapid than on the left with C and D. As shown in Fig. 2, this is easily accomplished by merely switching different C and D attenuators into the circuit.

Now, since the distance from X to B3 is less than that from B3 to Y, it is apparent that a greater voltage is required in the latter case. To do this, a voltage from generator 2, corresponding to the distance B3Y, is provided. Then a fixed amount of attenuation is switched into the circuit for conditions between B1 and B3.

To provide a voltage corresponding to the distance *ly*, a second auxiliary circuit is used. By subtracting this voltage from the sum of the other two voltages, it is attenuated much more quickly with factor A and B, as can readily be seen from inspection of the curve.

In this second auxiliary circuit, a different value of attenuation for factor C is also necessary. Attenuation for factor D, however, is the same as in the case of the first auxiliary circuit. Consequently, the second auxiliary circuit is connected into the first auxiliary circuit prior to factor D, thus modifying the output of both circuits.

In a similar manner, it was found that factor E affected all circuits equally. Therefore the first auxiliary circuit is connected to the main circuit prior to the attenuator for factor E. The current or voltage out of attenuator E is proportional to the time of flight under all conditions of all five factors illustrated.

Although still further refinement, if necessary, could have been added by including further auxiliary circuits, the circuit as shown will give values of time of flight that are within 0.01 sec., resulting in errors of less than 1 yard at 1,000 yards for a relative speed of 200 m.p.h.

Lateral and Vertical Deflections

Lateral and vertical ballistic deflections are computed with circuits similar to that just illustrated for time of flight. Voltage from the vertical ballistic deflection circuit is added to that from the vertical relative velocity generator. This voltage is then delivered to the electronic servo system. This is also true of the lateral ballistic voltage, except that it is added to the voltage from the lateral relative velocity generator, modified by a gun elevation attenuator. This is essential because the azimuth relative velocity generator is driven by turret rotation in the horizontal plane, while the sight is offset in a plane making a variable angle with the horizontal plane.

Just one other compensation must be added to those heretofore mentioned. Because of space and weight limitations, it is not practical to offset the guns in an aircraft turret. Accordingly, the sight itself must be offset in order to offset, in effect, the guns.

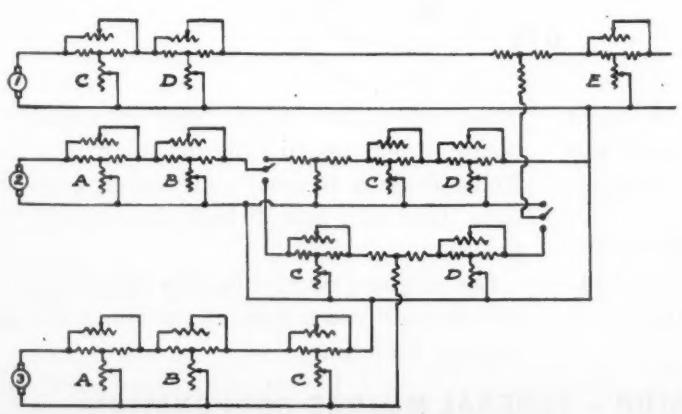

Fig. 2.

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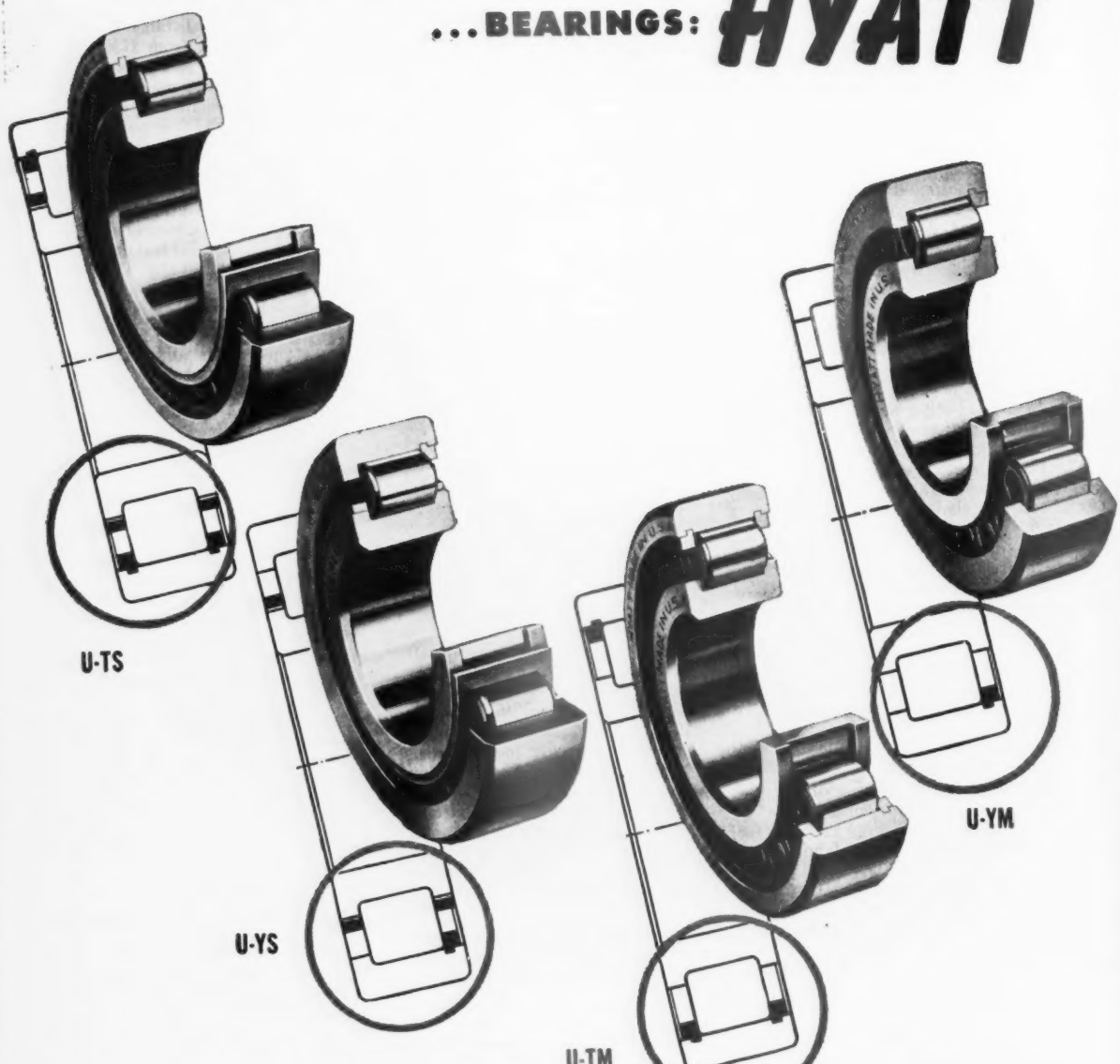

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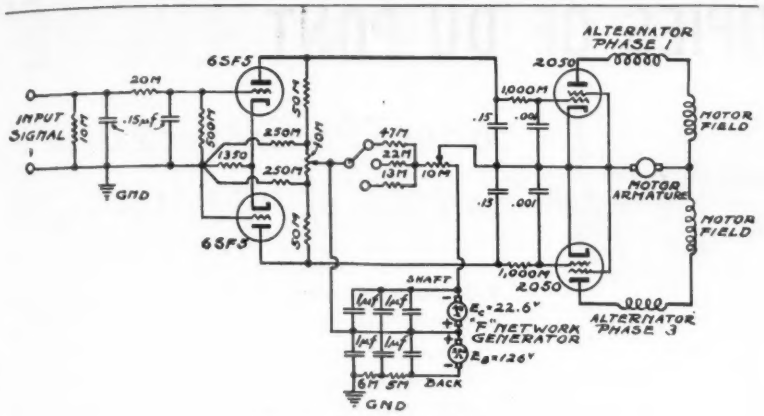


Fig. 3. Schematic-amplifier.

Effect of Offsetting Sight

However, since any offset of the sight tends to move it off of the target, the gunner has to rotate his turret to bring the sight back on the target. Since relative velocity is obtained from rotation of the turret, any such rotation to compensate for the offset of the sight will result in a false velocity being put into the system. Further, it will be found that any rotation to compensate for the offset of the sight will automatically cause a still greater offset. All this would result in an unstable system, making it impossible for a gunner to keep his sight on the target.

Now, when attempting to overcome this difficulty with a mechanical computer, a fixed amount of damping is introduced into this system. A time lag is thus, in effect, introduced into the system. It can be shown that this lag varies with range and all other conditions affecting the time of flight. The practical effect, however, is to limit the useful range over which the compensating sight is effective. It then happens that at extremely short ranges the sight is much too sluggish to be of any benefit, whereas at long ranges the damping is insufficient, making it difficult for the gunner to stay on the target. Strictly speaking, a fixed amount of damping provides a satisfactory correction for only one range and one set of all other conditions of altitude, air speed, azimuth, and gun elevation position.

However, it is possible to provide an exact solution to this problem. A small generator is provided on the same shaft as the motor that offsets the sight. The velocity of this generator is then proportional to the rate at which the sight is offset. The identical time of flight current as supplied to the field of the velocity generators is also supplied to the fields of the auxiliary generators on the sight. In this manner the velocity of offset of the line of sight is subtracted from the turret velocity to give true turret velocity. Of course, all velocities are multiplied by time of flight.

With this system the performance of the sight is the same at all ranges, and a true solution is obtained. No other compensating gun sight has this feature.

SERVO SYSTEM

The servo system of the Fairchild K-8 gun sight converts the voltages from the computing network into mechanical motion, offsetting the sight laterally and vertically. Great developments have taken place in the art of electronics within the past few years, and, without them, the electrical computing system would have been impossible. It is true that the computer would still compute, but electronics is required to make this computation available as a mechanical motion—the ultimate result required.

The K-8's servo system is unique because it involves a balanced d.c. amplifier that is precise enough for an accurate computer and yet rugged enough for use in an aircraft turret with attendant gun shock and airplane vibration. Fairchild designed this amplifier especially for this application. It has a sensitivity of 20 millivolts, performing throughout a temperature range from 65° below zero to 160° above zero and at a humidity range of 0 to 95 per cent. (It has actually performed satisfactorily while dripping wet.)

A circuit of this amplifier is shown in Fig. 3. Two such amplifiers are used in the complete unit: one of them for lateral deflection and the other for vertical deflection. To supply the split-

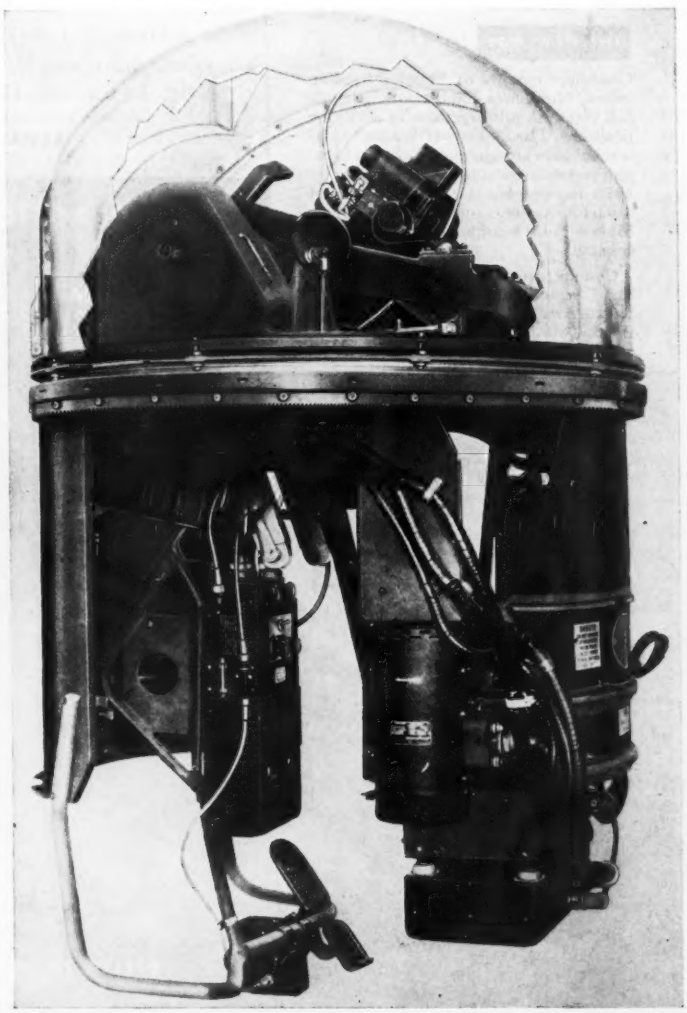
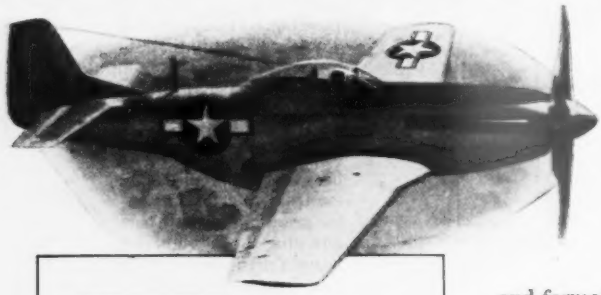


Fig. 4. The four components of the Fairchild K-8 gun sight mounted in an upper turret.

COCKPIT CANOPIES OF DU PONT "LUCITE"



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P-51 Mustang pilots fly under a protective canopy of transparent Du Pont "Lucite" methyl methacrylate resin. Because of its ability to be heated and formed into streamlined contours, this one-piece enclosure can be shaped in less time than was formerly required to produce the old-style canopy. This technique also reduces optical distortion during forming. In addition, the plastic "teardrop" reduces riveting operations and operations on alloy sheet stock as well as eliminating the use of machined parts.

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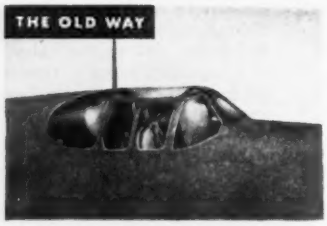
THE OLD WAY



Hood made of eight separate transparent panels, held together by metal ribs.

THE NEW WAY

One-piece canopy of "Lucite," shown below, eliminates blind spots, permits full vision in all directions in all flying positions. The ability of "Lucite" to be formed into streamlined contours helps reduce production time on canopies by 45% in man-hours. Slides back and forth for easy entrance and exit of pilot. Makes radio equipment instantly accessible.

Canopy formed by Swedlow Aeroplastics Corporation, Glendale, Calif., for North American Aviation, Inc., Inglewood, Calif.

field series motor as shown, a pair of matched 6SF5's are used to control a pair of 2,050 thyratrons. Any variation in tubes is taken care of by balance and bias adjustments. When the voltage in the airplane varies radically from standard voltages, it is sometimes necessary to adjust the controls to maintain maximum sensitivity of the amplifier. However, sensitivity will remain within about 10 to 40 millivolts over the voltage range specified of 26 to 32 volts. Even 40 millivolts would correspond to only a 2-yard error at 1,000 yards—well within the accuracy of the gun itself.

A specially designed four-phase alternator gives the thyratron plate supply. One phase is used for each of the four thyratrons, with two for each amplifier. The direction of rotation of the motor offsetting the sight is determined by which field is energized, depending on which thyratron fires. In turn, this is determined by the polarity of the d.c. signal on the input to the 6SF5.

The motor continues to drive until the voltage from the so-called bucking potentiometer (also driven by the motor at the same time the sight is offset) equals the voltage from the computing network. The input to the amplifier is reduced to zero when this occurs. Strictly speaking, it is reduced below the threshold sensitivity of the amplifier of 10 or 20 millivolts, when the thyratrons stop firing. The bucking potentiometers are supplied from a permanent magnet generator, driven by the same motor that drives the permanent magnet generators used for supplying the computing network. All the voltages of both the network and the bucking potentiometers thus vary together so that a null system is obtained.

It therefore happens that any variations in the speed of the motor driving the generators do not affect the computation in any way, and, because the bucking potentiometers are driven from the same shaft that offsets the sight, the mechanical backlash is held to an absolute minimum. There is no effect on the ultimate accuracy of the sight's offset by any backlash in the gear train of the motor.

Mechanical Construction

There are four main units in the K-8 sight. Figs. 4 and 5 show the sight as installed in a Martin upper turret. The four units consist of the sight itself, including the optical system for range finding and the sight offset motors, together with the auxiliary generators; the computer, mounted in front of the gunner; the power supply, mounted underneath the gunner's seat; and the foot pedal for range control, located on the turret's foot rest.

The sight itself is mounted in a yoke that is connected by means of a linkage system with the gun elevation sector. The entire unit elevates as the guns are elevated. The sight mount is pivoted in the yoke to provide for vertical deflection, and the sight itself rotates in the sight mount for lateral deflection.

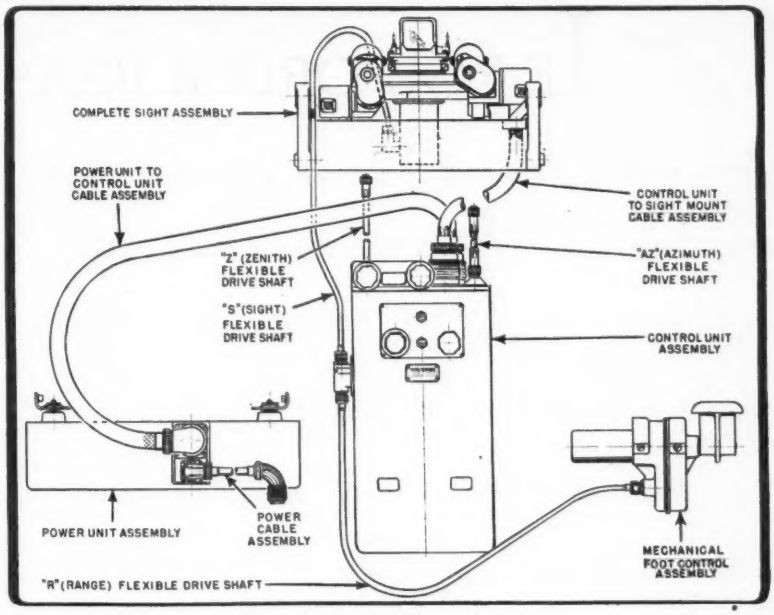

COMPLETE SIGHT ASSEMBLY
POWER UNIT TO CONTROL UNIT CABLE ASSEMBLY
CONTROL UNIT TO SIGHT MOUNT CABLE ASSEMBLY
"Z" (ZENITH) FLEXIBLE DRIVE SHAFT
"AZ" (AZIMUTH) FLEXIBLE DRIVE SHAFT
"S" (SIGHT) FLEXIBLE DRIVE SHAFT
CONTROL UNIT ASSEMBLY
POWER UNIT ASSEMBLY
POWER CABLE ASSEMBLY
MECHANICAL FOOT CONTROL ASSEMBLY
"R" (RANGE) FLEXIBLE DRIVE SHAFT

Fig. 5. Martin installation diagram.

The Optical System

The optical system consists of a reticle with a solid ring of light—or "magic ring"—with a dot in the center. This ring of light is variable in size to provide a means of determining the range of the target, and the size of this reticle ring is controlled by means of the foot pedal through a flexible shaft. The gunner himself does not have to know the range at all, because at the same time the foot pedal varies the size of the reticle ring it also positions the range attenuator in the computer unit, thus automatically setting the correct range into the computer. All the gunner has to do, then, is keep the reticle ring just encircling the target (see Fig. 6).

This use of a solid ring of light is a Fairchild innovation. Previous stadiometric range finders used in gun sights have consisted of two vertical lines adjustable in spacing. In some cases a variable-sized ring of seven or nine dots has been used. In Fig. 7, the advantages of a solid circle of light are very apparent. Unless the target is horizontal, it is difficult to determine the range with only two vertical lines as a guide. With a circle of dots (which, because of mechanical reasons, must consist of an odd number of dots), it is difficult to range under any conditions, since at no time are two dots opposite each other.

Only the Fairchild sight has the solid circle of light for ranging.

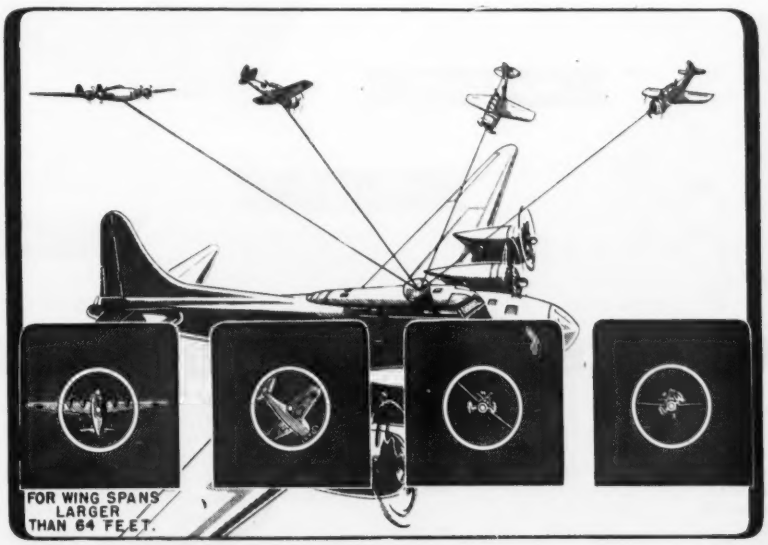


Fig. 6.

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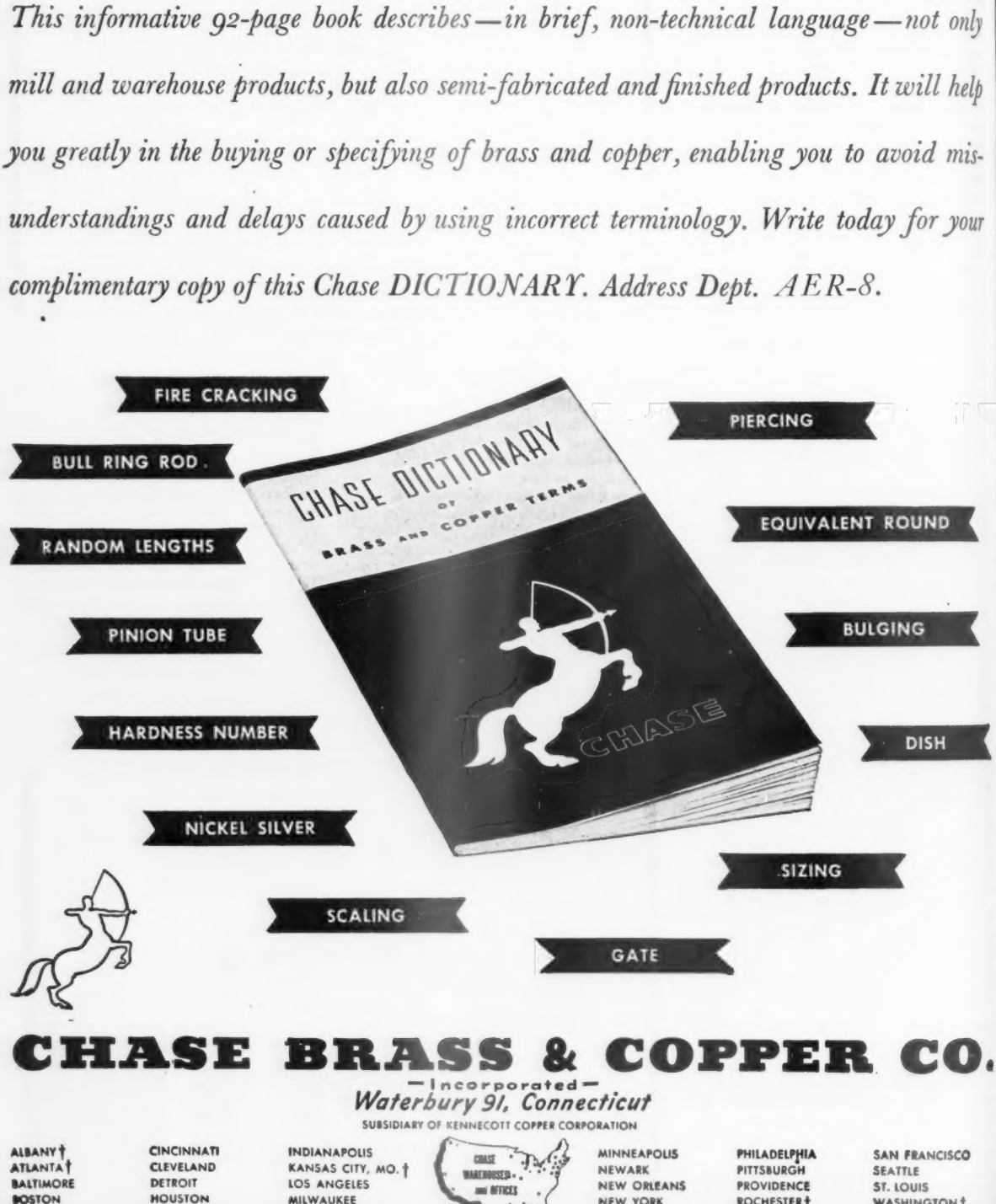

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Target Wing Span Correction

The wing span of the target airplane is one other factor that enters into the range computation. This factor, to eliminate mechanical linkages, is put into the K-8 computer electrically by means of potentiometers and vertical deflection circuits.

The computer unit is mounted between the gunner's knees where it is out of the way and yet where all the controls are readily accessible. It contains the attenuators used in the computing network, velocity generators, reversing switches, gearing to drive velocity generators and attenuators, and necessary controls for the system.

The velocity generators and azimuth gun elevation attenuators, as previously mentioned, are driven by means of flexible shafts connected to turret gearing. As also previously mentioned, range is put into the computer automatically by foot pedal operation. Indicated air speed and altitude are set in manually by means of controls located on the computer unit. Since they do not vary appreciably during combat, it is not necessary to have these factors put in automatically. Wing span of the target is also set in manually by means of a control located on the front of the computer unit. Indirect illumination is provided to all controls. Together with the sight light, this illumination is variable in brilliancy through a rheostat located on the computer unit. This permits use of the unit under any lighting conditions or even at night, when visual acuity must be especially maintained by reducing artificial lighting to an absolute minimum.

Power Supply

The power supply consists of the amplifier previously described, and the four-phase alternator for supplying the thyratrons. It also contains the permanent magnet network generators and a motor for driving them. This motor also drives the four-phase alternator. The network generators are specially designed units, with each generator having two windings and a commutator on each end of the shaft to provide two d.c. voltage outputs per generator. The computing network is supplied by four generators and the bucking potentiometer by a fifth generator. A sixth dual output generator supplies the B and C voltages for the amplifier. A single casting provides the common end bell for each of the six generators, giving automatic alignment for each gear of the gear train driving the generator. All six generators are simultaneously magnetized, and a special magnetizing jig was especially developed by Fairchild for this particular unit. Each generator is so magnetized as to give exactly the right voltage output required for each of the networks.

With one exception, all connections between the various units are electrical. This is the connection to the foot control, which is a flexible shaft that gives a large amount of leeway in the adaptation of this sight to various turrets.

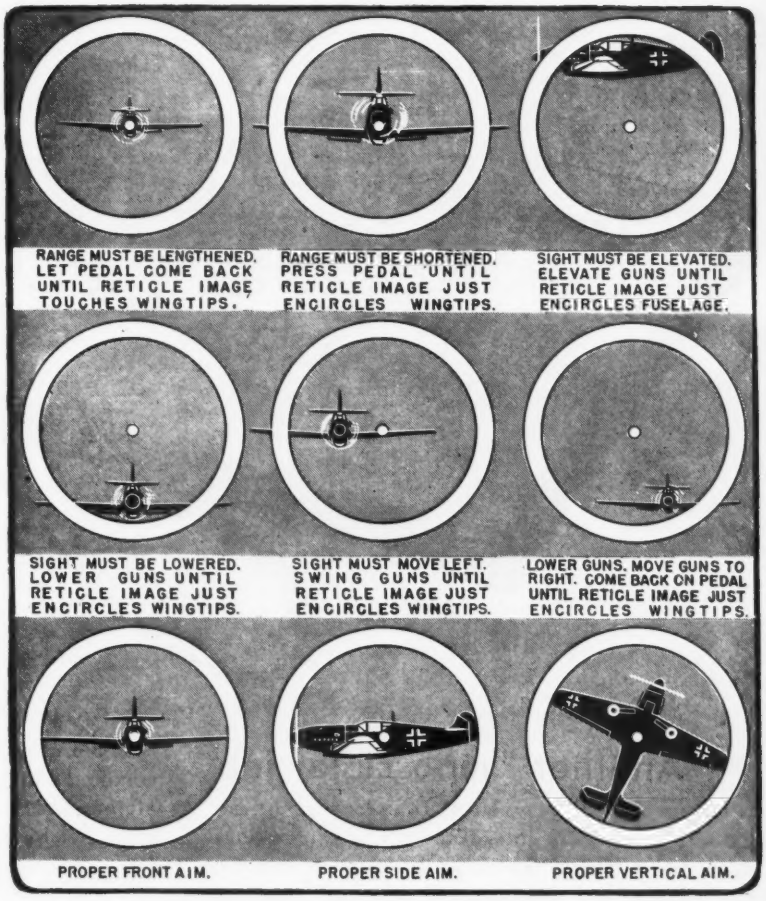

RANGE MUST BE LENGTHENED. LET PEDAL COME BACK UNTIL RETICLE IMAGE TOUCHES WINGTIPS.
RANGE MUST BE SHORTENED. PRESS PEDAL UNTIL RETICLE IMAGE JUST ENCIRCLES WINGTIPS.
SIGHT MUST BE ELEVATED. ELEVATE GUNS UNTIL RETICLE IMAGE JUST ENCIRCLES FUSELAGE.
SIGHT MUST BE LOWERED. LOWER GUNS UNTIL RETICLE IMAGE JUST ENCIRCLES WINGTIPS.
SIGHT MUST MOVE LEFT. SWING GUNS UNTIL RETICLE IMAGE JUST ENCIRCLES WINGTIPS.
LOWER GUNS. MOVE GUNS TO RIGHT. COME BACK ON PEDAL UNTIL RETICLE IMAGE JUST ENCIRCLES WINGTIPS.
PROPER FRONT AIM.
PROPER SIDE AIM.
PROPER VERTICAL AIM.

Fig. 7. Typical aiming problems.

Conclusion

A material advance in the art of aircraft gun sighting has been contributed to by the electrical computing system previously described. With this, the effective range of 0.50-cal. machine guns has been extended to more than 1,000 yards. Without it, the maximum range at which hits could be expected had been only 400 to 600 yards, and even then the probability of obtaining a hit had not been high. But with this sight, as much as 50 to 90 per cent as many hits has been obtained as when firing at a stationary target from a stationary platform. When it is realized that a pursuit ship must come within 200 to 400 yards in order to score effective hits, it is obvious that the K-8 sight provides a really deadly defense against pursuit attack. A pursuit ship, in order to press home an attack, must now fly through 600 or 800 yards of deadly accurate 0.50-cal. machine-gun fire from the bomber.

This electrical computing system, although developed primarily for use in an aircraft gun sight, will also have many applications in postwar developments. It is particularly adaptable for complex problems involving several variables difficult or impossible to handle by mechanical means. The more complex the problem and the more variables involved, the greater the necessity for use of an electrical system that can obtain an accurate solution without time lag and with a minimum of equipment and expense.

Many of the parts in the gun sight are standard radio equipment; a large part of the assembly work consists of wiring up the various components. It is therefore obvious that considerably less skilled help is required in the manufacture of electrical computers than for equivalent mechanical systems. Lower first cost and cheaper maintenance result.

The system used in the K-8 sight is for application on 26 to 32 volts d.c. An all a.c. computer, however, has been developed for commercial use, eliminating much of the rotating equipment required for the d.c. system with a consequent still further reduction of mechanical parts.

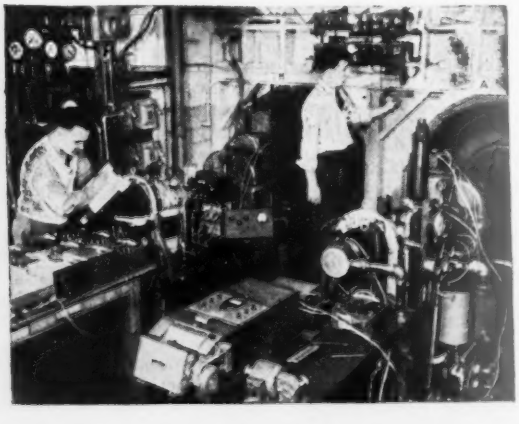
And many other improvements in methods of computation, component parts, and production methods have been recently developed. All of these will result in even greater accuracy with less equipment, not only for gun sights but also for use in many other applications now under investigation.

Another "impossible" job

has been whipped! Now, large, complex aircraft can have all the long-sought advantages of alternating-current main power. They can have it without the extra weight and nuisance of separate auxiliary engines, or d-c to a-c inverters.

ANOTHER G-E "FIRST"

The 400-cycle a-c system, first developed by G.E. with important co-operation from Sundstrand Machine Tool Company, offers a saving in weight over former systems that, alone, is highly significant. Added to this are the important advantages of having 400-cycle a-c motors throughout the ship. The elimination of motor brushes means elimination of the problems of commutation and brush wear encountered with d-c. Maintenance is reduced and simplified. You get better, more reliable performance at high altitude.



Parallel Alternator Operation

Until now, there has been no way of driving alternators from the main aircraft engines at constant frequency, and paralleling them on a common power line. Engine horsepower on many planes may be 100 times the alternator rating. The individual engine speeds may vary over a 4 to 1 range, with very rapid acceleration. Yet the alternator on each engine must run at constant frequency, must parallel reliably, divide load equally, and maintain electrical stability despite disturbances. To do this, paralleled alternators must be driven, under all conditions, *within one or two mechanical degrees of perfect synchronism.*

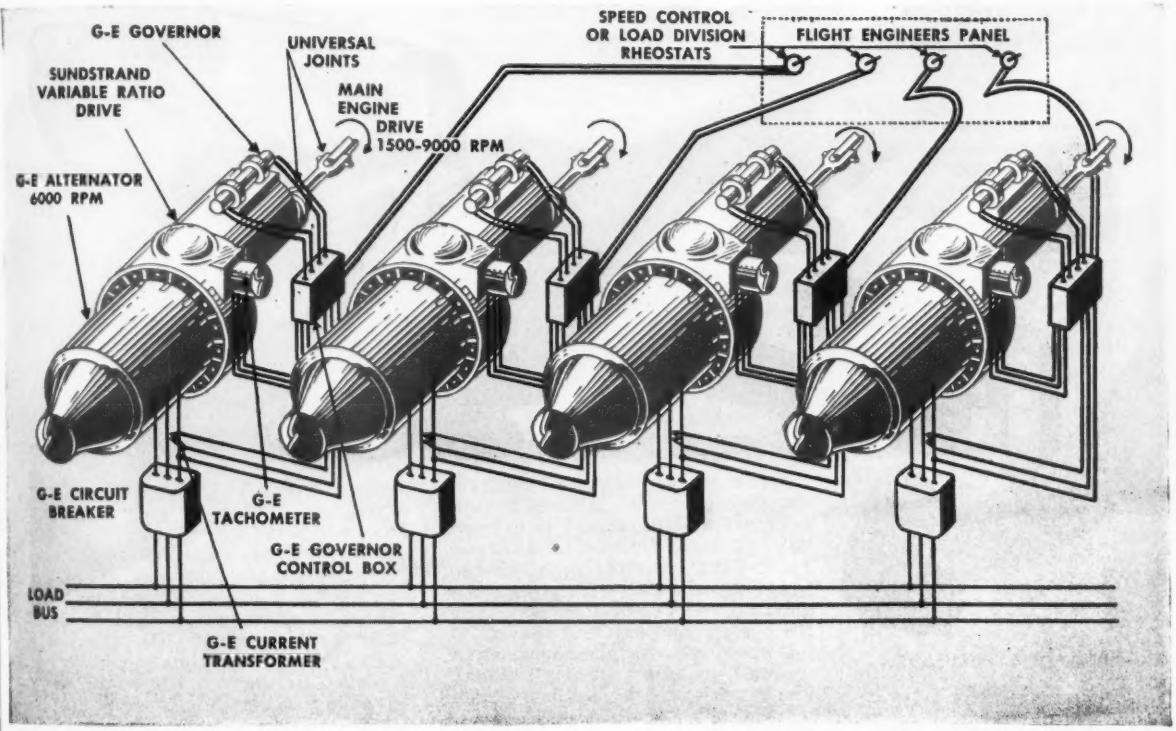
Extensive tests, under severe conditions duplicating those encountered on modern bombers, have convinced critical aircraft engineers that an airworthy solution of this tough problem has been found. The sketch at the right shows, schematically, how the new system works. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

← **TEST LABORATORY** where the new G-E 208-volt, 400-cycle, parallel system was proved practical. Two 40-kva alternators are driven from 450-hp aircraft engines under typically severe conditions of varying engine speeds, fluctuating electric load, and line faults, and their successful parallel operation is a routine every-day performance.

Buy all the BONDS you can—*and keep all you buy*

400 CYCLE A-C MAIN POWER

. . . FROM THE MAIN ENGINES DIRECT



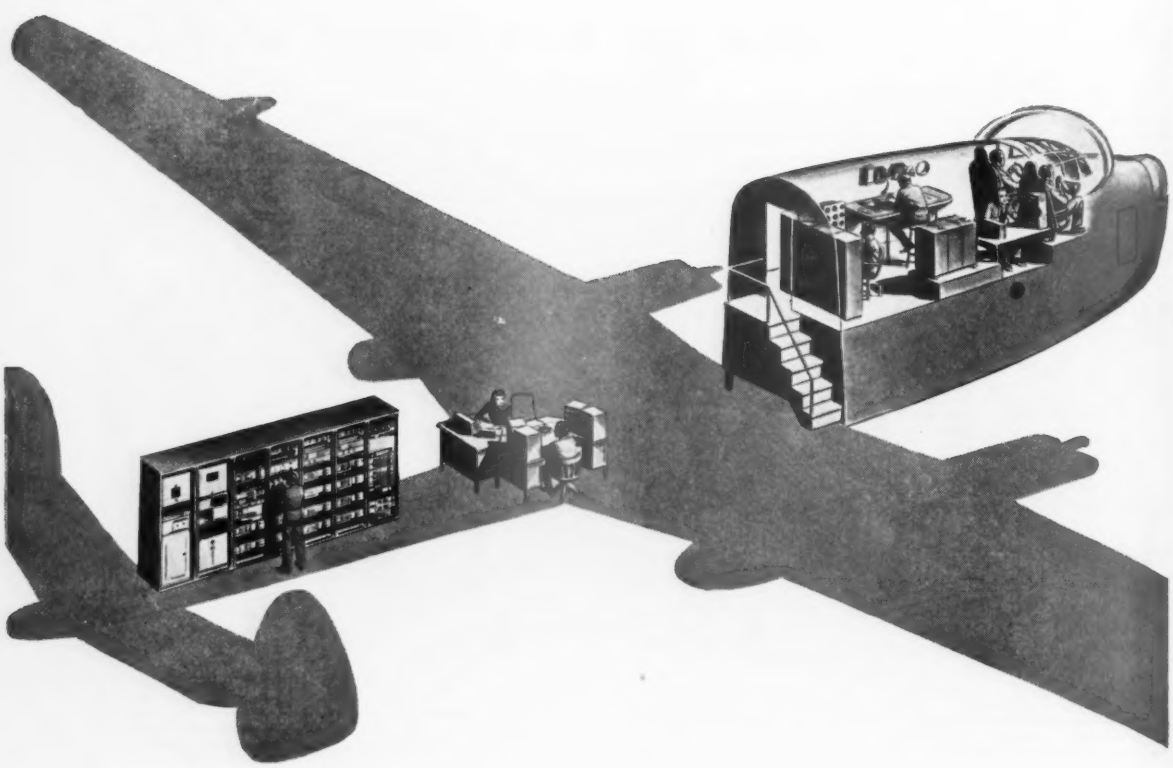
INTERPOSED between each engine and alternator is a hydraulic, variable-ratio drive developed by Sundstrand with G.E.'s co-operation. A G-E governor on each drive acts as a "master-mind," adjusting the drive to maintain constant alternator speed and to divide the load equally among the alternators. Circuit breakers (which will be remotely controlled from the flight engineer's panel) connect each alternator to the power line at the engineer's discretion. No special synchronizing controls or indicators are needed.

Accessories, such as voltage regulators, differential current relay, exciter ceiling relay, and reactive load-division transformers, are provided, although not shown on this sketch.

PRECISION PRODUCTS & ENGINEERED SYSTEMS FOR AIRCRAFT

GENERAL ELECTRIC

THIS SEA-GULL LIVES ON THE GROUND



This is a "flight trainer"— an electronically operated replica of the PBM-3 flying boat. It was conceived by the Bureau of Aeronautics and developed by Bell Telephone Laboratories to train Navy bomber crews on the ground.

The new crew climb a few steps to get in and from then on it is like being in a big plane at night. Controls tug against the pilot's grasp and "engines" roar in response to the throttle. From his desk, the instructor creates every situation of real flight — even to iced-up wings, conked-out engines and sudden air-pockets. The novice pilot and his crew get the feel of danger without the hazard.

Once the control dials are set, the various effects are automatically organized and set in motion by concealed machinery which includes 200 vacuum tubes, 60 motors, loudspeakers and hundreds of associated parts. Twenty Laboratories engineers worked more than a year developing the project. Drawings covered an area equal to 15,000 square feet.

This is only one of the 1200 projects in which our experience has been able to help the Armed Forces. What we have learned in devising electronic circuits to train flyers will help build better telephones.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for the Armed Forces at war and for continued economies and improvements in telephone service.

Institute News

Wright Brothers Lecture for 1945

Dr. Harold Roxbee Cox, Associate Fellow of the Institute of the Aeronautical Sciences and Fellow and Vice-President of The Royal Aeronautical Society, has been invited to present the Wright Brothers Lecture for 1945. The Lecture will be given on December 17 in Washington, D.C., and will be concerned with "British Aircraft Gas Turbines."

Dr. Cox was educated at Kings Norton School, England, and in 1918 joined the Aircraft Design Department of the Austin Motor Company. In 1922 he took advanced study in research and aeronautics at the Imperial College of Science and Technology and obtained a Diploma of the College and the degree of Doctor of Philosophy. In 1924 he joined the Royal Airship Works and was connected with the design of the airship R101.

Dr. Cox was later associated with various governmental departments and in 1936 became Head of the Air Defense Department of the Royal Aircraft Establishment. At the beginning of 1938 he was appointed Chief Technical Officer of the Air Registration Board and in 1940 became Deputy Director of Scientific Research in the Air Ministry. Later he became Director of Special Projects of the Ministry of Aircraft Production and was closely associated with all British gas turbine work.

He is now Managing Director of Power Jets (Research and Development) Limited, but by arrangement between the Ministry of Aircraft Production and the Air Registration Board he will continue to devote a part of his time to the civil administration activities of the latter body.

In addition to other honors that have been conferred upon Dr. Cox, he received the R38 Memorial Prize for his essay on external loads on airship structures and in 1940 delivered the Wilbur Wright Memorial Lecture of The Royal Aeronautical Society.

Gifts to the Aeronautical Archives

The Royal Aeronautical Society, through the courtesy of its President and Council, sent a Union Jack with a framed inscription reading: "This flag flew day and night over the building of The Royal Aeronautical Society during the London blitz, 1940–1941." A model of the original Sikorsky XR-4 helicopter, built in 1941 and flown to Wright Field, Dayton, Ohio, from Bridgeport, Conn., in May, 1942, was received through the courtesy of Col. H. F. Gregory of the Air Technical Service Command.

Col. J. Carroll Cone gave a book of aviation clippings covering the period July, 1934, through March, 1935. W. J. Pederson of Kansas City, Mo., gave aeronautical books. Bound volumes of *Air Force* from December, 1942, through December, 1944, were received from the Air Force Editorial Office through the courtesy of Lt. Col. James H. Straubel. A memorandum on the history of the Canadian aircraft industry was received from the Air Industries and Transport Association of Canada.

The British Airline Pilots Association gave back issues and a current subscription to its publication, *The Log*. The U.S. Naval Air Station at Pearl Harbor sent back issues of its weekly publication, *The Ford Islander*. The British Air Commission in Washington added 40 *R.T.P. Translations* and one *R.T.P. Bibliography* to the large number previously given. The Aircraft Laboratory of the Air Technical Service Command sent data on various wind tunnels, through the courtesy of Lt. Robert Crawford.

A lapel pin of Aerovias Nacionales de Colombia (Avianca) was received from Ralph Underdahl. The Eclipse-Pioneer Division of Bendix Aviation Corporation sent aeronautical books and 150 periodicals, adding to the large number previously given. *Aero Digest* gave 125 foreign aeronautical periodicals, adding to its previous generous gifts. Dr. Alexander Klemin gave pamphlets and company catalogs, including German, Polish, and Spanish material not previously in the Archives.

Documents relating to applications for new air routes and extensions of existing routes before the Civil Aeronautics Board were received from Braniff Airways, Inc.; Century Aviation Company; Eastern Airlines, Inc.; Northwest Airlines, Inc.; Transcontinental & Western Air, Inc.; and United Air Lines, Inc.

Additional gifts were received from American Airlines, Inc.; B-W Superchargers, Inc.; the Chamber of Commerce of the United States of America; Continental Machines, Inc.; Edward S. Evans Transportation Research; Fairchild Engine and Airplane Corporation; G. Felsenthal & Sons; General Electric Company; Francis G. Harrison; Charles W. Hoyt Company; Johns-Mansville Sales Corporation; Alfred Marchev; Simmonds Aerocessories, Inc.; Stinson Division, Consolidated Vultee Aircraft Corporation; Turco Products, Inc.; Zephyr Manufacturing Company; U.S. Air Technical Service Command; Board on Geographic Names; Bureau of Aeronautics and Bureau of Naval Personnel of the Navy Department; Civil Aeronautics Administration; Civil Aeronautics Board; U.S. Government Printing Office; Office of Education; Office of War Information; War Production Board; and the House Document Room.

Corporate Member Expands

Solar Aircraft Company, San Diego, Calif., a Corporate Member of the Institute, has purchased the Precision Castings Division of B. F. Hirsch, Inc., of New York. The division will hereafter be operated as a subsidiary of Solar Aircraft Company.

Corporate Member in Merger

It was officially announced on June 29 that the Jacobs Aircraft Engine Company, a Corporate Member of the Institute, has been merged into Republic Industries, Inc., of New York. The organization will hereafter be known as the Jacobs Aircraft Engine Company, a Division of Republic Industries, Inc. The merger was effected by an exchange of stock of Jacobs Aircraft Engine Company for that of Republic Industries, Inc. According to the statement, no change of personnel or operating management is contemplated.

Sections and Branches

Miami Section

The following have been elected as temporary officers of the Miami Section, pending completion of the organization of the Section, to serve until the first formal election: Chairman, J. C. Shroeter; Vice-Chairman, Capt. E. W. Gureasko; Secretary-Treasurer, C. R. Ursell.

New York Section

At a meeting of the New York Section held at the McGraw-Hill Auditorium in New York on June 25, a paper "Application of Radar to Air Transport" was given by D. W. Rentzel, President of Aeronautical Radio, Inc. The talk was limited to the following general discussion of radar and its application to air transport: (1) limitations and

DESIGNED to fly at high altitudes, tomorrow's planes will climb into the sky like homesick angels . . . carrying us literally to the end of the rainbow in comfort and safety. • Pacing this dream with reality, engineers are at this moment perfecting designs for the planes of the future. For example, planes the size of this giant aircraft call for even greater feats of engineering in the field of precision instruments to make certain that they will have the maximum amount of efficiency and safety. • In this connection, Kenyon is proud to play an important role. Since the beginning of the war, Kenyon has designed and delivered *in quantity* and *on time* countless precision instruments for American war planes. • In addition, Kenyon instruments are used in many commercial planes, such as the giant Pan American clipper—renowned for its services in transporting vital personnel and cargo during the war. • In peace as in war, Kenyon's engineering staff is at the service of American aviation—in the development of dependable *precision* instruments, from the *basic design to the completed product.*

KENYON

INSTRUMENT CO., INC.

HUNTINGTON, L. I. NEW YORK

DESIGNERS OF BETTER PRECISION PARTS FOR THE AMERICAN AVIATION INDUSTRY

general characteristics of radar equipment; (2) immediate postwar applications to air-transport aircraft; (3) possible additional applications to air-transport aircraft.

Philadelphia Section

The Philadelphia Section held a meeting on June 27 at the Engineers Club of Philadelphia. A discussion took place concerning papers to be presented at meetings during the coming year. Various topics were suggested, including the scope of future papers, plans for increasing the membership of the Section, frequency of meetings, and means for stimulating membership attendance. The six papers that have been submitted by Section members were discussed.

The speaker of the evening was J. E. McDonald, Chief Aerodynamicist of the G & A Aircraft Company, who spoke on "Discussion and Demonstration of Dynamics of Rotor-Craft Ground Resonance." The paper included a simplified discussion of the dynamics of rotating wing aircraft which induce ground resonance, blade motion associated with body motion, and a physical demonstration by means of a model of the coupling between the body and blade motion. The conditions of dynamically stable and unstable performance of rotating wing aircraft while operating on the ground were outlined. The motions of, and forces on, the blade and body were illustrated by a discussion of the calculations for obtaining stable ranges of operation and suitable dampers for critical ranges. The model used was composed of rotor blades suitably pinned to a hub that was rotated by an electric motor. A spring restraint was applied to the hub shaft to simulate the rotating wing aircraft landing gear. Stroboscopic light was used for ease of observation, and dynamically stable and unstable conditions were produced.

Phoenix Section

On June 29, members of the Phoenix Section were taken on a conducted tour of Thunderbird Field No. 1. B. B. Moeur, Jr., of Southwest Airways, Inc., Flight Instructor at the field, guided the group, first showing them the flight-line activities from the veranda of the operational-control building. The members then inspected and operated P-40 and AT-6 planes that were anchored on supports for ground-school training and received individual instruction in the operation of the landing gears, control surfaces, the engine and its accessories, the radio, and intercommunication equipment.

John Neace, of Southwest Airways, Inc., head of the ground school, gave a talk about "Aircraft Engine Construction and Operation," explaining the characteristics of the Allison, the Merlin, and the Wright Cyclone engines. The advantages of the different features of construction and operation

I. A. S.

Special Meetings Schedule

1945

October 4–5, 1945
DETROIT MEETING

October 25, 1945
WASHINGTON MEETING

December 17, 1945
WRIGHT BROTHERS LECTURE, Washington, D.C.

The Officers and Council of the Institute invite participation in the Technical Sessions of the Meetings of the Institute.

The Meetings Committee will consider for inclusion on the program complete papers, or outlines or summaries of proposed papers.

Information for Participants

(1) Complete papers, or outlines or summaries should be submitted in triplicate at least four months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

(2) Each paper should be so planned that it may be presented within a time limit of 45 minutes.

(3) All papers submitted will be considered for publication in the **Journal of the Aeronautical Sciences** or the **Aeronautical Engineering Review.** While a paper should be planned to take only 45 minutes for presentation at a meeting, the written presentation may have a maximum length of approximately 15,000 words.

(4) All material received will be submitted to the Meetings Committee. Authors will be notified, in ample time to prepare the complete paper, whether or not their papers can be scheduled for presentation.

All correspondence should be addressed to
The Meetings Committee
Institute of the Aeronautical Sciences
1505 RCA Building West
30 Rockefeller Plaza
New York 20, N. Y.

ALL IN THE DAY'S WORK

A helicopter can easily hover low enough for pilot and passengers to talk with people on the ground nearby. The Kellett XR-8 helicopter, shown above, "stood still in the air" by the hour, at only *one foot altitude*, during its test period. When all was ready, restraining cables were loosed and its cross-country flying career began.

The XR-8 can fly forward, backward or sideways. It can rise or descend vertically, permitting take-offs and landings in any space large enough for safe clearance of its own blades.

Kellett has been active in the design of rotary wing aircraft—helicopters and autogiros—for over 16 years. More advanced models than the XR-8 are on Kellett drawingboards and in Kellett workshops today.

The final word in helicopter design will not be written for some time to come. Many engineering problems must be solved before helicopters are brought into practical daily use. Progress already achieved, however, more than justifies the man-hours that must still be spent by Kellett and other organizations active in this field. Their objective is to make helicopters available for exacting travel and transport jobs, in areas and under conditions where no other air, land or water craft can operate.

Kellett Aircraft Corp., Upper Darby (Philadelphia), Pennsylvania.

KELLETT

were emphasized and demonstrated on the classroom models. The Allison ignition system and a typical fuel system were demonstrated under various operational conditions.

Seattle Section

A dinner meeting of the Seattle Section was held at Chamber of Commerce Hall on June 20. In accordance with O.D.T. regulations, attendance was limited to local residents who would not require the use of railroad transportation or hotel accommodations. This is in accordance with the policy governing all meetings of the Institute and its Sections and Branches.

Lloyd C. Shackelton, Service Engineer of General Electric Company, spoke on "The Boeing B-29 Remote Control Turret System." His explanation was accompanied by motion pictures and an operational demonstration.

University of Cincinnati

Regular meetings of the University of Cincinnati Branch have been deferred for the present because of the temporary diversion of students to other activities. A social affair was held on June 9 in conjunction with the members of the local student branch of the American Society of Mechanical Engineers.

University of Colorado

The March 25 meeting of the University of Colorado Branch was addressed by Philip F. Moore, who spoke on "Engineering in the Aircraft Industry."

A joint meeting took place on April 15, at which the student members of the Institute were joined by those of the American Society of Mechanical Engineers and the Society of Automotive Engineers in holding an "open house" session at which the undergraduates of the University and the general public were guests. The engineering laboratories of the University were opened to the public, and the equipment was operated and demonstrated. Prior to the admission of the general public, the motion-picture film *Gas Turbines* was screened by a representative of the Allis-Chalmers Manufacturing Company.

At the meeting on May 20 two films titled *Unfinished Rainbows* and *Wright Builds for Air Supremacy* were shown.

On June 8 the Senior members of the Branch made a tour of the Denver Modification Center. Those participating in the tour were shown many of the mechanisms used in the control and operation of the B-29 and were conducted through the airplane, making a careful inspection of its construction. The film *Birth of the B-29* was shown.

Illinois Institute of Technology

At a technical meeting on June 15 the following papers were given by Student members: "Jet Propulsion," by Sidney Mayster; "Helicopter Design," by Edward Goetsch; and "Post-war Transport," by Albert J. Spooner. These presentations were judged by a board consisting of Prof. P. C. Huntly, Dr. C. O. Harris, and Mr. Fiezenheizer. Sidney Mayster was judged the winner and a tie was recorded between the other two contestants for second place.

Iowa State College

At the June 11 meeting of the Iowa State Student Branch, C. W. Milligan, General Manager of the Des Moines, Iowa, plant of Solar Aircraft Company, spoke on "Engineers in the Business World." The following awards were made to the members of the Branch: Best Grades to Graduation Senior, Cecil Parsons; Best Design, Kent Hawkins.

Massachusetts Institute of Technology

The following officers were elected at a meeting on June 4: Chairman, Henry W. Pickford, Jr.; Vice-Chairman, James C. Chabot; Secretary-Treasurer, Bernard J. Haverback; Program Chairman, Donald E. Robison.

University of Minnesota

A combined technical and business meeting was held on June 5. Robert Aldrich, Head of the Airport Commission of the twin cities of Minneapolis and St. Paul, spoke on the subject of "Airport Planning."

New York University

On June 5 it was decided that the previously discussed plans for organizing an engineering newspaper would be dropped for the present because of pressure of other work affecting the members of the Branch and other organizations. The War Department film *Wings of the Army* was shown.

On June 19 the following officers were elected: Chairman, Martin A. Snyder; Vice-Chairman, William Steibel; Secretary, Frank Taranto; Treasurer, George Kaden. Films shown were *The Bell Helicopter* and *The Bell Aircomet—XP-59A Twin Engine Jet Propulsion Fighter Plane.*

University of Notre Dame

The University of Notre Dame Branch held a brief informal meeting on June 6 at which Verne Hubka was elected Chairman. The election of other officers and other formal actions were postponed until the opening of the forthcoming term. On June 10 the final social function of the term was held, when the members participated in a picnic at Lake Christiana, near South Bend.

Polytechnic Institute of Brooklyn

The following officers were elected at a meeting on June 5: Chairman, Morris Morduchow; Vice-Chairman, Peter Thomas; Treasurer, John Ohler; Secretary, Frederick Zeuthen.

At the conclusion of the elections, a talk was given about sandwich construction by Dr. N. J. Hoff, Associate Professor of Aeronautical Engineering at the Polytechnic Institute. He reviewed briefly the early types of airplane construction and then explained the principles of papreg-cellulose acetate sandwich construction as applied to modern aircraft building. Test specimens that had been subjected to edgewise compression were shown.

Spartan College of Aeronautics

The election of officers on June 2 resulted as follows: Chairman, Egbert F. Au Yong; Secretary, Treasurer, and Vice-Chairman, J. W. Alldredge; Auditor and Program Chairman, Estill Sherrill. Following the meeting a social gathering was held for the graduating engineering students.

On June 13 the members presented a gift to the retiring Chairman, Jack Wintzell, as a token of his leadership and ability during the period of his term as Chairman of the Branch.

Virginia Polytechnic Institute

At a technical meeting on June 7 the film *No Substitute for Safety* was shown.

News of Members

Phillip Andrews has been elected Second Vice-President of the Aviation Writers Association.

Ralph D. Baker has returned to his position as Associate Professor of Mechanical Engineering at the University of Utah.

Mark C. Benedict has joined Westinghouse Electric Corporation as Section Engineer in charge of Installation in the Aviation Gas Turbine Division.

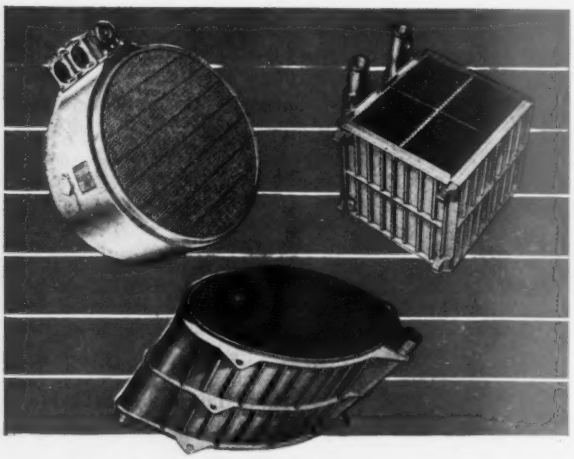
Lewis A. Binegar is now Flight Test Engineer with Boeing Aircraft Company.

Charles I. Blomer has joined Republic Aviation Corporation (Indiana Division) as Stress Analyst.

Raymond K. Bucher is with Pan American-Grace Airways, Inc., as Maintenance Engineer.

Richard J. Cerny has become Project Engineer on aircraft cabin pressurizing equipment with the J O Manufacturing Company.

Martyn V. Clarke is Senior Stress Analyst with North American Aviation, Inc.



How to Reduce Weight of Heat Exchangers by 66⅔%

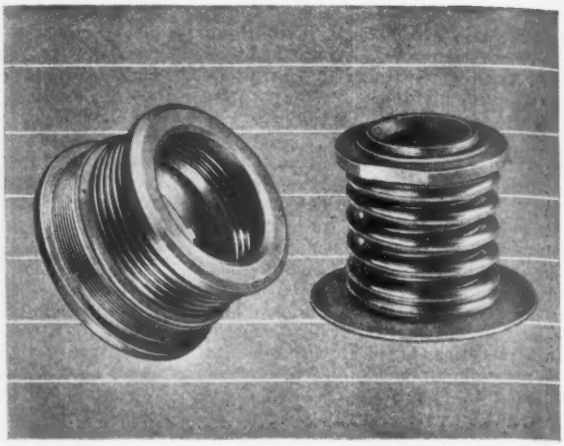
When aluminum replaces copper in tubes, plates, shells and other parts . . . and when aluminum alloy replaces soft solder as the bonding material . . . the weight of heat transfer units drops as much as 66⅔%.

Such drastic weight reduction is made possible by Clifford's discovery of a method for brazing aluminum in thin sections . . . a discovery that has already paid the three following extra dividends to designers of several types of USAAF aircraft.

1. Clifford's heat-treatable aluminum tubes withstand temperatures up to 275°F. . . . whereas copper tubes anneal and weaken long before that point is reached.
2. Clifford's aluminum plates, shells and other parts defy much higher temperatures and pressures than other metals commonly specified for heat transfer units.
3. Clifford's high-temperature aluminum alloy bonding material has a melting point several times higher than that of soft solder.

"FEATHER-WEIGHTS" FOR YOU?

Feather-Weight Oil Coolers and Coolant Radiators for USAAF planes are now monopolizing Clifford's patented aluminum brazing method . . . but its use in postwar heat transfer units for automotive, heating, cooling and ventilating applications is now in the planning stage. Your inquiry is invited. *Clifford Feather-Weights —Save ⅔ the weight . . . same size and shape.*



Sealing Rotating Shafts Against Loss of Gases or Liquids Under Pressure

A seal assembly may be one of the smallest components of a fuel oil pump, gear box, air compressor, refrigerant compressor, fluid coupling, torque convertor, water pump, etc. — but its unsatisfactory operation can cause plenty of trouble.

When a shaft seal does go wrong, the reason can usually be found among the answers to these questions: Was the bellows strong enough? Was the seal nose distorted during diamond-facing or by high operating temperature? Was the bearing material properly selected? Were the ends of the thrust spring parallel under load? Was the seal assembly properly soldered? Were installation conditions up to specification?

Clifford . . . first to introduce hydraulically-formed bellows to industry . . . and with a record of having applied them to some of industry's most difficult seal problems . . . knows how a seal assembly can go wrong and takes *all* the necessary steps to insure satisfactory operation. For example, the larger bellows seal assembly illustrated above could only be produced because Clifford pioneered a new method of silver-soldering the steel nose to the Hydron Bellows and flame-hardening it without annealing the brass bellows.

You, too, can save time, money and trouble by consulting Clifford before your designs are too far advanced. A discussion of your problem does not obligate you in any way. *Clifford—First with the Facts on Hydraulically-Formed Bellows.* Clifford Manufacturing Co., 560 E. First Street, Boston 27, Mass.

CLIFFORD *Feather Weight* **OIL COOLERS AND COOLANT RADIATORS**

HYDRAULICALLY-FORMED BELLOWS HYDRON

Captain Luis de Florez, U.S. Navy, has been appointed assistant chief of the recently established Naval Research Laboratories. This new office is a consolidation of the Special Devices Division of the Bureau of Aeronautics, of which Captain de Florez was director, with the Office of Research and Development and the Office of Patents and Inventions.

Orland E. Esval, Director of Aircraft and Marine Instrument Research at Sperry Gyroscope Company, Inc., was one of the two recipients of the National Prize of the American Institute of Electrical Engineers as coauthor of a paper titled "Electric Automatic Pilots for Aircraft."

Athanas P. Fontaine is now Director of Aircraft Development at Bendix Aviation Corporation.

Frank C. Fromherz has been assigned to active duty as Junior Assistant Engineer with the rank of Second Lieutenant in the Reserve of the Public Health Service.

William G. Griswold, Jr., has joined Consolidated Vultee Aircraft Corporation as Flight Test Engineer.

Stanley A. Hall has entered the service of Pan American Airways, Inc., as a pilot for service with the China National Aviation Corporation.

Donald C. Hunt has become a member of the Faculty of the University of Detroit, Aeronautical Department, and also Aeronautical Consultant for the Wickman Corporation of Detroit.

Albert R. Jacobs, Vice-President and Chief Engineer of the Jacobs Aircraft Engine Company, has been elected a Vice-President and Director of Engineering of that organization, which has become a Division of Republic Industries, Inc.

Martin J. Juhola has joined H. L. Yoh Company as Design Engineer.

William D. Kennedy, Vice-President and Manager of the Cincinnati Plant of the Wright Aeronautical Corporation, has been named Vice-President and General Manager of Wright Aeronautical Corporation. He will make his headquarters at Paterson, N.J.

Albert E. Lombard, Jr., who has been serving as Special Assistant to the Director of the Aircraft Resources Control Office of the Office of Production Management, has been appointed Engineering Consultant of Consolidated Vultee Aircraft Corporation.

Peyton M. Magruder has been appointed Director of Commercial Aircraft Sales of The Glenn L. Martin Company.

Frank S. Mayer, Jr., is a Stress Engineer at Northrop Aircraft, Inc.

Robert W. McCloy has joined the Faculty of the University of Illinois as Assistant Professor in the Department of Aeronautical Engineering.

Ralph E. Middleton was recently elected Vice-President in charge of Engineering of the Hydraulics Division of Aireon Manufacturing Corporation.

Fred W. Ocvirk has been appointed to the Faculty of Johns Hopkins University as an Aerodynamicist in the Applied Physics Department.

George A. Page, Jr., Director of Engineering of the Airplane Division of Curtiss-Wright Corporation, has been relieved of many of the technical and manufacturing details in the engineering branch and will concentrate on refinement of the CW-20P Commando and the development of other commercial aircraft.

Edmund T. Price has become President of Solar Precision Castings, Inc., subsidiary of Solar Aircraft Company.

Leonard Raymond has entered the service of Socony-Vacuum Oil Company, Research and Development Laboratories.

Wilmot L. Rodman is a Structures Engineer in the Ranger Aircraft Engines Division of Fairchild Engine and Airplane Corporation.

Paul E. Steele is now an Aerodynamicist with North American Aviation, Inc.

William B. Stout, Chief of the Stout Research Division of Consolidated Vultee Aircraft Corporation, has been given an additional assignment, through agreement with Consolidated Vultee, by which he will also serve as head of the postwar automobile development work for Graham-Paige Motors Corporation.

Herbert K. Strass has joined the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics as an Aeronautical Engineer.

George Tharratt has been appointed General Manager of the California Division of Lear, Incorporated. He was formerly Chief Aeronautical Engineer with a manufacturer of aircraft accessories.

Karl Unholtz is now Development Engineer with M. B. Manufacturing Company, Inc.

Nathan F. Vanderlipp, formerly General Manager of the Buffalo plant of Curtiss-Wright Corporation, has become Executive Engineer for the Airplane Division, supervising all engineering operations in the plants at Columbus, Buffalo, and Kenmore.

Sam A. Vinci has been appointed Electrical Design Supervisor at Lockheed Aircraft Corporation.

Omer L. Woodson, recently with Ryan Aeronautical Company and before that with Bell Aircraft Corporation, has announced formation of the O. L. Woodson Company in Los Angeles to render consultant service for the development of products, production methods, plant facilities, and management.

Shao Wen Yuan has joined the faculty of Polytechnic Institute of Brooklyn to do research work.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Allen, Fred Charles, M.E.; Asst. Supervisor of Strength and Tests Group, Douglas Aircraft Co., Inc.

Byers, Horace Robert, ScD. in Meteorology; Prof. of Meteorology, University of Chicago.

Chillson, Charles White, B.S. in Chemical & Mechanical Engineering; Chief Research Engineer, Propeller Div., Curtiss-Wright Corp.

Hurty, Walter Carl, B.S. in Ae.E.; Chief of Structures in Special Projects Branch, Lockheed Aircraft Corp.

Resos, Eugene P., B.Sc. in C.E.; Preliminary Designing, North American Aviation, Inc.

Elected to MEMBER Grade

Dickard, Herbert Edward, Jr., B.S. in Ae.E.; Design Engineer, Beech Aircraft Corp.

Fisher, William Garrow, Chief Designer and Director, Cunliffe-Owen Aircraft Ltd. (England).

Hawkins, John Francis, Chief Draftsman, Fleet Aircraft, Limited (Canada).

Hinshaw, Carl John Williams, C.E.; Member of Congress, House of Representatives.

Lampland, Donald Oscar Qualee, B. of Ae.E.; Sr. Staff Engineer, Pan American Airways, Inc.

Oehrli, John Wesley, M.E.; Engineer in Charge of Design and Development, McCulloch Aviation.

Priest, Eric Frederick, Lt., Technical Engineer, South African Air Force.

Redding, Arnold Hurxthal, B.S. in M.E.; Section Engineer, Flow Research Section, Westinghouse Electric Corp.

Rowley, Elton Holcomb, Chief, Engineering Flight Test, Wichita Div., Boeing Aircraft Company.

Stolarik, Eugene, M.S. in Ae.E.; Project Engineer, Lawrance Aeronautical Corp.

Tuhy, Ivan Emmanuel, Layout Designer, The Glenn L. Martin Co.

1646 Precision Electronic Items

This MALLORY Catalog Lists Them All

FOR convenience in ordering electrical and electronic components, keep your Mallory catalog at your elbow. It contains both physical and electrical data on more than 1600 items in the line of standard Mallory Approved Precision Products.

Use of this Mallory catalog can pay substantial dividends to design engineers. Selecting parts for a big production run . . . trying to eliminate extra tooling time for special items . . . it's frequently possible to find *standard* Mallory products that are just right—while designs are still being blueprinted.

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McClellan, Stephen A., President, Specialties, Inc.

Murray, James Lore, Major, Supervisor of Maintenance, U.S. Army Air Forces.

Ostrand, Arnold Oestreicher, M.S.; Sr. Aircraft Stress Analyst, Otis Elevator Company.

Phillips, William Hewitt, S.M.; Head, Stability and Control Section, Flight Research Div., Langley Mem. Aero. Lab., N.A.C.A.

Rodgers, Oliver Eliot, Manager, Aviation Gas Turbine Design Engineering Div., Westinghouse Electric Corp.

Vincenti, Walter, A.B.; Aeronautical Engineer, Ames Aero. Lab., N.A.C.A.

Wing Shee, George Leo, Sr. Service Engineer, Service Dept., Airplane Div., Curtiss-Wright Corp.

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Hamilton, Tonea (Miss), Research Analyst, American Liquid Gas Corp.

Miller, Wayne Francis, Supervisor of Field Service, Airplane Div., Curtiss-Wright Corp.

Elected to Technical Member Grade

Curtis, George Augustus, Engineer, Cessna Aircraft Co.

Fay, Joseph Patrick, B.A.; Project Engineer, U.S. Army Air Forces.

Moos, Henry, Design Draftsman, Otis Elevator Company.

Simmons, Stanley Herbert, Jr. Engineer, Pan American Airways System.

Snavely, Harry Edgar, B.S. in Industrial Engineering; Principal Engineering Draftsman, Davis-Monthan Field.

Waugh, John Dean, Technical Editor, Public Relations Dept., Propeller Div., Curtiss-Wright Corp.

Transferred from Student to Technical Member

Bergamini, Herbert Van Wie, B.Ae.E.; Ensign, U.S.N.R.

Dolkas, Constantine Basil, B.Ae.E.

Gaz, James, Ae.E.; Liaison Engineer, Wright Aeronautical Corp.

Grey, Ralph Eugene, Jr., B.S. in Ae.E.; Aero. Engineer, Aircraft Engine Research Lab., N.A.C.A.

Grome, Walter Marion, B.S. in Ae.E.

Haggar, Joseph Marion, Jr., B.S. in Ae.E.; U.S. Navy.

Homsher, Paul T., B.S. in Ae.E.; Jr. Engineer, Curtiss-Wright Corp.

Laster, Walter R., Jr., B.Ae.E.; Liaison Engineer, Conner Plant, Briggs Mfg. Co.

Lew, Henry Guock, B.Ae.E.; Research Assistant, Polytechnic Institute of Brooklyn.

Marshall, John Warren, B.S. in Ae.E.; Ensign, U.S.N.R.

Martin, Carl John, B.Ae.E.; Aero. Engineer, Bureau of Aeronautics, U.S. Navy Dept. (Washington, D.C.).

Mazanowski, Kazmier John, B.Ae.E.; Midshipman, U.S.N.R.

Mc Neil, Edwin Burt.

Palmer, George Marshall, Jr., B.Ae.E.; Aerodynamicist, Consolidated Vultee Aircraft Corp.

Parsons, Cecil Eugene, B.S.; U.S. Navy.

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Popkess, John Edwin, B.S. in M.E.; U.S. Navy.

Skinner, William Frank, B.S. in Ae.E.

Statler, Irving Carl, B.S. in Ae.E., B.S. in Eng. Math.; Pvt., U.S. Army Air Forces.

Swift, Selma Caroline, B.Sc.; Engineering Asst., Lockheed Aircraft Corp.

Elected to Affiliate Grade

Burgess, Samuel L., Cpl., U.S. Army Air Forces.

Necrology

Edson Fessenden Gallaudet

Edson Fessenden Gallaudet, an Associate Fellow of the Institute, died at his home in Pine Orchard, Conn., on July 1.

Mr. Gallaudet was a native of Washington, D.C., where he was born on April 21, 1871. He was graduated from Yale University with the degree of Bachelor of Arts in 1893 and received his Doctor of Philosophy degree from Johns Hopkins University in 1896. His first business connection was with Westinghouse Electric & Manufacturing Company as an Aeronautical Engineer in 1896 and 1897, and from 1897 to 1900 he served as an instructor in Physics at Yale University. From 1900 to 1908 he was connected with the Cramp Shipbuilding Company at Philadelphia and with the Platt Iron Works Company at Dayton, Ohio. In 1910 he founded the Gallaudet Aircraft Company and invented a triple gearing arrangement by which three separate aircraft engines were connected in such a manner as to drive propellers together or separately. He was credited with inventing numerous other devices for improving wing construction and control mechanism of aircraft, as well as a large flying boat. His gearing device was reported to have been tested successfully in a flight across the Pacific from California to Hawaii.

Mr. Gallaudet received a French pilot license for the Nieuport monoplane and a United States pilot license for the Wright biplane in 1911.

In recent years Mr. Gallaudet had been active as an independent Aeronautical Engineer. In addition to his membership in the Institute, he was a member of the Providence Engineering Society, the Aero Club of America, the Society of Automotive Engineers, and the Agawam Hunt Club of Providence, R.I.

Clifford Burke Harmon

Clifford Burke Harmon, one of the pioneer aviators of the United States, donor of the Harmon air trophies, and founder of the International League of Aviators, died on June 25 in Cannes, France, where he had resided since 1922.

Mr. Harmon was born at Urban, Ohio, July 5, 1868, and was educated in public schools and by private tutors. His business interests were in real estate, in which he was successful as a developer of suburban residential properties, but his hobby and principal outside interest were in aeronautics. He was a balloonist in the early part of the century, and, with Augustus Post, he set an American record for balloons at the St. Louis Centennial Exhibition in 1909.

In 1910 he made a pioneer airplane flight across Long Island Sound, establishing an over-water distance record. It is reported that in the same year he painted the outline of a battleship on the ground and "bombed" it with bags of plaster in an early demonstration of aerial bombing that interested Army and Navy officers. He served with the Lafayette Escadrille in the first World War and later was a Major in the United States air service.

Mr. Harmon was credited with many early accomplishments in flying, establishing numerous records with airplanes purchased from French and American manufacturers. In addition to the Harmon trophies, he was the donor of various other prizes and incentives that were instrumental in advancing the cause of aviation.

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Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Detail and Layout Engineers, Stress Analysts, Aerodynamicists, and Design Engineers—For development work and production engineering work in Engineering Division. Must be citizens of the United States and have a certificate of availability. Call in person or write to Chief Administrative Engineer, Boeing Airplane Company, Wichita, Kan.

Radio, Electronic and Telephone Engineers, Electronic and Mechanical Draftsmen. One of the largest manufacturers of a wide variety of electronic and communications equipment in the world is fully prepared and ready with an ambitious postwar program. Write to Personnel Manager, Federal Telephone & Radio Corp., 591 Broad Street, Newark, N.J.

Aeronautical Engineer—To teach Senior year subjects of aeronautical engineering course including design and stress analysis. Address inquiries to The Aeronautical University, Inc., 116 South Michigan Avenue, Chicago, Ill.

Aircraft—Chief of Structures. Eight years' experience. Write McDonnell Aircraft Corporation, St. Louis 1, Mo.

Aircraft—Chief of Weights. Five years' weight experience. Write McDonnell Aircraft Corporation, St. Louis 1, Mo.

Aerodynamicists, Stress Engineers, and Vibration Analysts. Needed for the Helicopter Division of Bell Aircraft Corp., Niagara Falls, New York. Write full details to R. A. Wolf, Chief Engineer, Helicopter Product Division.

Aeronautical Engineers, Senior Layout Draftsmen, Junior Layout Draftsmen. Experimental engineering unit working on new types of postwar airplanes. Seeking individuals interested in commercial field and who can produce without supervision. Location Roosevelt Field. Address Special Project C, Fairchild Engine and Airplane Corp., 30 Rockefeller Plaza, New York 20, N.Y.

Aeronautical Engineers—for immediate and urgent top priority work, the long-established Aeronca Aircraft Corporation seeks Project Engineers, Stress Analysts, Weight Engineers, and Layout Draftsmen. Since Aeronca's postwar plans are complete, with peacetime production in the offing, these positions offer unusual permanent opportunities for qualified men who can comply with W.M.C. requirements. Write in complete detail to Aeronca Aircraft Corporation, Box 00, Middletown, Ohio.

Aircraft Stress Engineers thoroughly familiar with the analysis of aircraft structures, aircraft controls, and all component parts for work on helicopters. Excellent opportunities for personnel interested in rotary-wing aircraft. Applicants must comply with W.M.C. regulations and be draft exempt. Apply by letter, giving references, to Administrative Engineer, Kellett Aircraft Corporation, Plant #2, Lansdowne Avenue above State Road, Upper Darby, Pa.

Personnel Needed—Executive and Administrative experience in manufacture of aircraft. Positions available in several fields; Factory and Production Management, Matériel, Tooling and Engineering. McDonnell Aircraft Corporation, Ambassador Building, St. Louis 1, Mo.

Aerodynamicist, Senior Layout Draftsmen, Junior Layout Draftsmen. Interesting high-speed, jet aircraft project. Location New York City. Small organization. Opportunity for personal recognition. Send complete résumé or call or wire for interview. Postwar continuation. Address Dean C. Smith, Fairchild Engine and Airplane Corporation, 30 Rockefeller Plaza, New York 20, N.Y.

Aircraft Engineers—Experienced aerodynamicist; layout and detailed draftsmen; structural designers; senior drawing checkers; static test engineer; stress analysts; technical illustrators; technical writer. These positions immediately available in critical war work at attractive salaries. Postwar prospects excellent. Applicants must comply with W.M.C. regulations. Address replies giving education, experience, background, age and draft status to Personnel Manager, Edo Aircraft Corporation, Terminal Building, Flushing, N.Y.

Wind Tunnel Model Men—Qualified wind tunnel model builders and/or designers for new small company. Desire men with extensive experience in wood and metal model work to close tolerances and in model project organization and planning. All models and instrumentation are for various aircraft companies and aerodynamics laboratories. Airmail complete qualifications and experience to Aerolab Development Company, 1992 Lincoln Avenue, Pasadena 3, Calif.

Aircraft Engineers—Positions available in Clifton & Caldwell, N.J., for Tool & Gage Engineers. Also engineers for manufacturing process, production methods, also design engineers, Seniors & Juniors. Manufacturing operation sheet writers, designers, tool & gage; gage analysts, tool & gage draftsmen. Applicants must have Aeronautical Industrial Manufacturing experience. Must have certificate of availability. Call in person or write Employment Office, Curtiss-Wright Corp., Propeller Division, 143 Getty Ave., Clifton, N.J.

Detail and Layout Draftsmen, Stress Analysts, and Design Engineers needed for development work in the Engineering Department. Must be citizen, not employed in essential war industry, or have a certificate of availability from the U.S. Employment Service Office or the War Manpower Commission of your area. Address inquiries to Curtiss-Wright Corporation, Airplane Division, Buffalo, N.Y.; Attention: Director of Engineering.

Detail & Layout Draftsmen, Stress Analysts, Design Engineer, Assistant Project Engineer on development work in the engineering department. Address inquiries to Edo Aircraft Corporation, 136-48 Roosevelt Avenue, Flushing, L.I., N.Y.

Aerodynamicist or Flight Test Engineer—Ability to analyze flight test data on advanced high performance aircraft. Submit qualifications to McDonnell Aircraft Corporation, Ambassador Building, St. Louis 1, Mo.

Aeronautical Cataloging Librarian. Experienced. Permanent position in New York City. Open October, 1945. Address inquiries to Box 330, Institute of the Aeronautical Sciences.

Aircraft Layout or Stress Engineer. Mid-west location. New aircraft designing. Write full particulars. Address inquiries to Box 329, Institute of the Aeronautical Sciences.

Engineer—To supervise manufacture of new airplane. Aeronautical background and heavy shop supervision experience absolutely essential. Good wages. Pleasant working conditions. Write all information in detail. Address inquiries to Box 328, Institute of the Aeronautical Sciences.

Aeronautical Engineer—With experience in structures and stress analysis and the writing of reports for submission to the Civil Aeronautics Administration. Address inquiries to Box 326, Institute of the Aeronautical Sciences.

Patent Engineer—Familiar with patent disclosures and procedures.

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Barco Products are making the Japan bombing run regularly these days on the death-dealing Superforts. Barco Brake Line Assemblies are the heart of the B-29 landing gear, selected for their proved safety value and low maintenance. And Barco Flexible Joints (winterized for service conditions) are used to protect fluid-conveying systems. Write us about the Barco 3000-pound pressure Swivel Joint prepared especially for aviation use.

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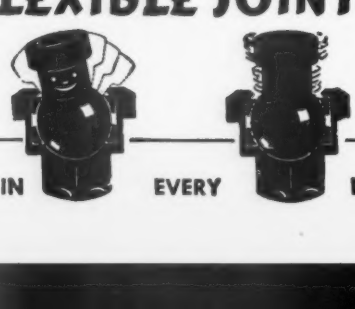

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Electronic and Mechanical Engineers—Large radio corporation presently engaged in urgently needed war work for the armed forces needs engineering personnel in all categories. Sound peacetime future with an established leader in the field of Electronics. Located in East and mid-West. Write in detail. Address inquiries to Box 317, Institute of the Aeronautical Sciences.

Mechanical Engineer or Physicist—Not subject to draft, experience in product development, research, and testing. Must have sufficient mathematical background to perform calculations in stress and vibration analysis, thermodynamics, aerodynamics, and general mathematics upon own initiative. Some knowledge of combustion desirable. Wanted for research staff of well-established aircraft accessory company with good postwar prospects, located on the West Coast. Salary dependent on qualifications and experience. Address inquiries to Box 311, Institute of the Aeronautical Sciences.

Aeronautical Engineer, Chief of Structures, Stress Analysts—Excellent opportunity for qualified men with medium-sized aircraft manufacturer on postwar work. Commercial experience preferred but not necessary. Applicant must comply with W.M.C. regulations. Address inquiries to Box 309, Institute of the Aeronautical Sciences.

Instrument Designer—Medium-size industrial organization offers excellent opportunity. Position will pay top salary. Present and postwar possibilities are unusually attractive. Man must hold an Electrical or Mechanical Engineer Degree, and have knowledge of optics or electronics. He should also have at least four years' practical experience in instrument design. Please write in detail. Your reply will be held in strict confidence. W.M.C. regulations observed. Address inquiries to Box 304, Institute of the Aeronautical Sciences.

Stress Analysts and Aerodynamicists—Required for aircraft design work U.S. Naval Aircraft Prime Contractor. Address inquiries to Box 297, Institute of the Aeronautical Sciences.

Assistant Professor—To teach Mechanics, Strength of Materials, and Physics in a small Mid-western College. Must have Master of Science Degree, preferably in Engineering or Physics. Salary dependent on qualifications and experience. Position permanent. Address inquiries to Box 291, Institute of the Aeronautical Sciences.

Draftsmen—Four or five, wanted by large research and development organization; experienced in the layout of aircraft structural members. Four or five years' experience required; knowledge of stress analysis desired. Experience in wing or fuselage group would prove satisfactory. Address inquiries to Box 282, Institute of the Aeronautical Sciences.

Aerodynamics Engineer—Practical experience wanted by well-known long-established mid-west manufacturer to conduct technical research and market development in ventilating and air-cooling division. Attractive salary for man of ability and ambition. Address inquiries to Box 275, Institute of the Aeronautical Sciences.

Mechanical & Electronic Engineers—Large engineering firm engaged in essential work with growing backlog of postwar jobs needs engineering personnel in all categories: Designers, Layout & Detail Draftsmen, Checkers, etc. Location Manhattan. W.M.C. rules observed. Address inquiries to Box 263, Institute of the Aeronautical Sciences.

AVAILABLE

Graduate Aeronautical Engineer—Bachelor and Master of Aeronautical Engineering degrees from N.Y.U. Two and one-half years' engineering in aircraft manufacturing and $2^1/_2$ years' engineering in air-line maintenance and operation. Recently completed engineering and economic studies on major postwar aircraft for air-line operation. Will receive Masters in Commerce and Finance in 2 years. Draft exempt and release available. Excellent references. Address inquiries to Box 332, Institute of the Aeronautical Sciences.

Aeronautical Engineering Student. Three years of college. Desires full-time engineering work, preferably in New York. Address inquiries to Box 331, Institute of the Aeronautical Sciences.

Service Engineer, B.S. in M.E.—Commercial pilot, licensed mechanic and navigator, also foreign licenses and international aviator's license. Fifteen years' aviation experience ranging from small flying service to foremost U.S. and foreign factories. Recent duties include: installation engineer, test pilot, service engineering, publications manager, asst. service manager of large engine factory. Spent last 2 years exploring sales possibilities in all Latin-American countries. Speaks French, Spanish, Dutch, German and understands Portuguese. Sees no further scope for improvement after 6 years with present employer and is interested in position with a future in progressive organization where his experience and abilities can be fully utilized. Address inquiries to Box 327, Institute of the Aeronautical Sciences.

Personal Plane Designer—Corporate Executive now with prominent lightplane manufacturer. Eight years' experience development, test, manufacture, numerous military projects, six years' successful design and supervision personal aircraft, gliders, liaison, special purpose military, postwar, cropduster aircraft. Familiar C.A.A., Army, Navy contract negotiations, design requirements, cost estimating. In charge engineering, handbook, inspection, flight test, experimental departments. Under 40, married. Address inquiries to Box 325, Institute of the Aeronautical Sciences.

Executive-Engineer-Test Pilot—World War II veteran with two years' recent supervisory experience in design and flight-testing for large commercial aviation corporation. Seven years of college engineering followed by five years of active duty as commanding officer of aircraft advanced-base, maintenance, repair, experimental, and operational units. Active experimental test pilot in service and during last two years in commercial aviation. Combat and test experience in over 50 different types of single and multi-engine land- and seaplanes. Recent experience in gas turbines and jet propulsion. War veteran status precludes any difficulty in leaving present position. Airline engineering and operation or manufacturer's flight research and design most desirable. Address inquiries to Box 324, Institute of the Aeronautical Sciences.

Airport Engineer—Five and a half years' experience as airport engineer. Responsible for site selection, layout, design, and inspection during construction of over 40 airports in eastern states. Experience also includes speaking before municipal governing bodies and local service clubs on frequent occasions. Registered professional engineer and have a student pilot's license, recently soloed. Desire connection as airport consultant with engineering company or airline. Particularly adapted to liaison work and promotion. Any location considered. W.M.C. compliance. Address inquiries to Box 323, Institute of the Aeronautical Sciences.

Stress Analyst, Design and Development Engineer—B.S. in Aeronautical Engineering and Engineering Mechanics, four years' experience in research, design, development and stress analysis pursuits with prominent aircraft concerns. One year on analysis and static test of pure monocoque wing. Two years as supervisor of group engaged in design and stress analysis of bombardment type airplane. One year with entire structural responsibility for extensive structural modification for large patrol type aircraft. Desires position with responsibility for structural design or

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stress analysis. Address inquiries to Box 321, Institute of the Aeronautical Sciences.

Assistant Professor of Aeronautical Engineering at large mid-west school desires change of position in October. Broad aeronautical background with aerodynamics as major field. West coast location preferred. Will consider position in industry. W.M.C. will be complied with. Address inquiries to Box 320, Institute of the Aeronautical Sciences.

Analyst—Maintenance Engineer. Age 37. Exceptional record large scale maintenance and improvement of aircraft availability in military aircraft. Some Latin-American experience. Excellent Spanish. Position desired with aggressive airline in need of obtaining more flight hours from available aircraft. Address inquiries to Box 318, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Aero E., 1941. Single. Four years' experience as Propeller Blade Designer and Stress Analyst. Desires work in Experimental Research, Test Engineering or Development with an airline. Will work anywhere in U.S. or foreign country. Will travel. Available now. Can comply with W.M.C. regulations. Address inquiries to Box 315, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate engineer with B.S. and M.S. degrees. Nine years of continuous experience on Army, Navy, and C.A.A. projects. Past experience includes positions as Chief Structures Engineer, Chief of Aerodynamics and Flight Test, Assistant Chief Engineer, and Consultant Engineer. Have demonstrated ability to direct technical development of designs ranging from small private airplanes to large high-speed military aircraft. Prefer responsible position where technical skill is required. Address inquiries to Box 314, Institute of the Aeronautical Sciences.

Aeronautical Engineer and Test Pilot with design, experimental engineering and flight experience desires suitable position doing development work or experimental engineering and/or flight testing. Available immediately. Address inquiries to Box 312, Institute of the Aeronautical Sciences.

Research Analyst and Technical Writer. Twenty-one years' experience, including Patent Law, Medicine, Aeronautics, and Internal Combustion Engineer, Liaison and Production Planning, including LPG. Several years in Engineering Department of Aircraft Manufacturer. Familiar with setting up technical records and systems. West Coast preferred. Address inquiries to Box 310, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Pilot—Graduate engineer over 15 years' experience in design, research, and manufacturing; eight years as experimental test pilot; eighteen years' flying experience. Desires position with company offering postwar future combining engineering and flying. Past employment includes several years as consulting engineer and chief engineer with large company. No objection to traveling. Address inquiries to Box 307, Institute of the Aeronautical Sciences.

Airline Engineer—Graduate Aeronautical Engineer, B. of A.E. with major in Air Transport. Two years' extensive practical experience with major air line as maintenance and operations engineer. Thoroughly familiar with problems relating to design, performance, and economic studies of present and postwar aircraft. Desires change but wishes to remain in air-line industry and continue with same type research and development. Address inquiries to Box 306, Institute of the Aeronautical Sciences.

Sales and Service Engineering Executive, fifteen years' experience in airplane, engine and accessory design, service and sales, air-line maintenance engineering. Seeking position offering executive responsibilities organizing and directing sales and service activities or air-line maintenance engineering organization, either in this country or Latin America. Long residence in Latin America. Speak both Spanish and Portuguese. Will consider major oil company aviation department. Excellent references. Available for immediate employment. W.M.C. requirements complied with. Address inquiries to Box 305, Institute of the Aeronautical Sciences.

Engineer—B.S.Ae.E. Eight years' varied aircraft experience, project engineer, design group leader, structural design and stress analysis. Interested in essential position in Los Angeles area. Release available. Address inquiries to Box 303, Institute of the Aeronautical Sciences.

Engineer—Visualizer. Has broad and varied experience in the application of industrial visual aids (graphic illustrations) to employee indoctrination, production, plant layout, tool design, methods, cost analysis, sales, and service manuals. Developed methods to prepare such drawings economically. Desires additional work from medium size company for own office. Address inquiries to Box 302, Institute of the Aeronautical Sciences.

Industrial Designer—Stylist. Varied experience in product and interior design. Recently completed redesign of series of aircraft-engine test equipment. Desires additional clients for aircraft accessories styling or small plane interior styling. Address inquiries to Box 301, Institute of the Aeronautical Sciences.

Works Manager or Executive Engineer: College education; 39 years of age; married and have family. Broad experience in Industrial Engineering; Management; Production and Engineering. Proved performance in capacities of Works Manager; Plant Manager; Executive Engineer; Plant Superintendent; Industrial Engineer and Experimental Research Manager. Nine years aeronautical; seven years steel fabrication (all phases); and three years' heavy construction experience. Extensive Army and Navy contacts. Now in East. Will consider any location including foreign. Statement of availability and references will be furnished. Address inquiries to Box 300, Institute of the Aeronautical Sciences.

Helicopter Engineer (B.S. in Aero. Engineering) 5 years' experience in helicopter theory, design, and construction; has just completed successful helicopter for small company; did entire design, stress, weights, and aerodynamics. Desires position in supervisory design capacity in reliable company. Address inquiries to Box 298, Institute of the Aeronautical Sciences.

Aeronautical Engineer and Consultant—Seventeen years in the aviation industry on military and commercial airplanes including development, design, administration and direction of engineering groups, company representative at Service procurement centers and engineering flight test experience. Desires a permanent and responsible position in engineering or engineering sales or as a technical representative in the aviation industry or allied field. Address inquiries to Box 294, Institute of the Aeronautical Sciences.

Production Executive—Mechanical engineer with five years' administrative experience in all phases of aircraft construction including line assembly methods, Tool and Jig design and one year as Director of experimental. Served ten years as Works Manager of large plant fabricating precision metal parts for automatic actuating mechanisms. Thoroughly familiar with modern precision machine shop practice serving eight years as Plant Manager. Manufacturing experience totals 26 years. Automotive background. Enjoy a wide acquaintance among subcontractors in central and eastern area. Will travel. Address inquiries to Box 292, Institute of the Aeronautical Sciences.

Research—Economic Planning and reporting work desired. Good background in aviation manufacturing industry, B.S. Degree in Economics, now working toward Masters Degree in Economics. Connection desired with aviation manufacturer or transport line. Address inquiries to Box 286, Institute of the Aeronautical Sciences.

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John Q. Citizen is part of the story. His interest in private flying, fast transportation, local air terminals, air strips and air parks; his support of air shows and exhibits; his interest in aviation literature, books, education and research; his participation in aviation organizations . . . all these are specific ways in which he will help make peace through Air Power a reality.

◀ PART TWO ▶

American Business also will contribute much to the progress of American Aviation and Air Power. For aviation shrinks the distance between markets; opens new sales channels; means closer coordination of far-flung plants and access to almost any part of the world in a matter of hours instead of days and weeks. And, in the case of Helicopters, even to places normally inaccessible by air.

◀ PART THREE ▶

Government, too . . . Federal, State and Municipal . . . will play its role. Already many steps have been taken to promote aviation and Air Power and other steps are under way. Training facilities . . . roads and highways . . . safety regulations . . . encouragement and development of scientific flying aids and international air transportation . . . perfection of airport facilities . . . creation of commissions charged with promoting aviation wisely and for the benefit of all . . . these are just some of the areas in which Government can be and *is* a vital part of this story.

◀ PART FOUR ▶

And . . . the Aviation Industry. Under the stimulus of war the progress and technical advancement of the Aviation Industry has been an industrial miracle. The entire industry is dedicated to a continuance of the scientific research which has made America foremost in the Air. At Bell Aircraft we shall put into civilian service the skills and achievements identified with the Airacobra, the Kingcobra, the Bell Built B-29 Superfortress, the Airacomet (America's First Jet Propelled airplane), the products of our Ordnance Division and the Bell Helicopter. The challenge of Peace will provide us with a stimulus as urgent as the desperate needs of war.

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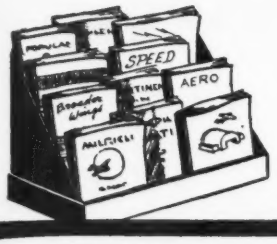

Periodicals

Accessories and Equipment

Design and Application of High-Pressure Coefficient Axial-Flow Fans. J. G. Sawyer. A discussion is given of the theories involved in the design of high-pressure fans and their applications. The writer outlines the characteristics of the conventional axial-flow fan and its limitations, as well as the Schicht principle and the Wattendorf fan theory. He traces the work leading to the development of the high-pressure coefficient fan through the abandonment of the conventional airfoil and the use of highly curved, closely spaced blades that guide the fluid in the directions arrived at by a vector analysis. This method is stated to be relatively simple and the same as that used in turbine-blade design. The theory of the blade development and the application of the fan to aircraft-engine cooling and other possible uses are discussed. *Journal of the Aeronautical Sciences*, July, 1945, pages 281–284, 9 illus.

Bellows Assembly Controls Fuel Mixture. J. A. Bolt. A brief description is given of a mixture-control unit for aircraft-engine carburetors, which is designed to provide automatic compensation for changes of altitude. A cross-sectional view of this complete self-contained unit is shown. *Machine Design*, June, 1945, page 128, 1 illus.

High Altitude Oil Systems. W. L. Wheeler. Methods are suggested for investigating the performance of aircraft oil systems, especially new designs, to reduce to a minimum the difficulties encountered in prototype airplanes at high altitudes. Primary consideration is given to oil systems of the purely conventional type but the method of analysis which is developed will allow special cases to be investigated. The writer discusses trouble caused by the various components of the system not being compatible, the altitude performance of spur-gear pumps, factors affecting aeration, oil system failures, oil loss, and breather design. A number of performance charts are shown. *Industrial Aviation*, May, 1945, pages 56–58, 60, 96, 97, 8 illus.

Shetland Auxiliary Power. Supplemented by a 2-page schematic drawing, a detailed description is given of the two 60-hp. Rotol generating plants from which the Short Shetland derives its auxiliary power. Particulars pertain to the design and construction of the engines, their installation in the flying boat, and the auxiliary power services they render. A table of data includes the performance and dimensions of the unit, the engine specifications, and the dimensions and weight of the unit complete in soundproof box. *The Aeroplane*, June 1, 1945, pages 628–631, 5 illus.

Curved Glass Windshields. J. M. Crone. Information is given about the curved laminated glass windshield, the use of which is stated to be highly desirable from the standpoint of safety, aerodynamics, and appearance. Using the Commando as a specific example, the writer gives data, based on an air speed of 240 m.p.h. at sea level, which indicate the increased speed and range, and reduced drag obtained with the curved windshield. It is noted that the outstanding objections to the use of curved windshields have been the breakage attributable to difficulty of installation and the loss caused by the inaccurate and impractical methods of determining the amount of optical distortion present in each pane of glass manufactured. Particulars are given about a means of inspecting windshield glass for optical properties which has been developed to reduce fabrication costs and helps to increase aerial safety. *Automotive and Aviation Industries*, June 15, 1945, pages 20, 21, 114, 116, 118, 120, 5 illus.

Design of Hydraulic Systems. Part VI. Howard Field, Jr. This is the sixth article of a series devoted to the subject of hydraulic-system design. The characteristics, uses, and limitations of filters are discussed and the development of filters is briefly reviewed. Information is given about the type, size, and location of filters in a hydraulic system. *Product Engineering*, June, 1945, pages 409–411, 4 illus.

Air Actuates B-29 Bomb-Bay Doors. A detailed description is given of the pneumatic actuating system that provides snap opening and closing of the Superfortress's bomb bay doors. Besides reducing opening time to less than 1 sec. and closing time to 2 or 3 sec., it is claimed that the new mechanism also reduces the weight of the airplane by approximately 94 lbs. from its former weight with the electric-motor-driven screw-type of actuating equipment. The pneumatic actuating scheme consists of two interconnected but separately operating systems. Each system has a compressor, reservoir, actuators, and a four-way valve for each set of doors. Control of the pneumatic actuated doors is similar to that of the screw-type system in that the pilot, bombardier, and crew members all have

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Photo of Boeing B-29 Superfortress courtesy Boeing Aircraft Co.

30-40-50 degrees and more below zero! That's how cold it is up where the B-29's fly. And our boys who fly them must be given every protection that science can devise to guard men against those paralyzing temperatures, to keep them as warm and comfortable as possible on their hazardous missions.

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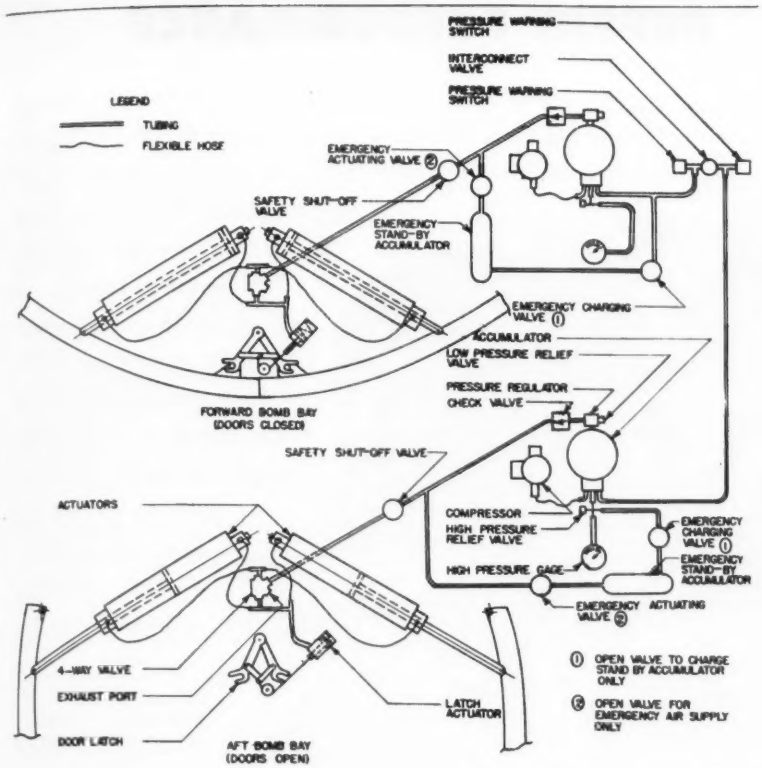

Illustration Courtesy Boeing Aircraft Company

Schematic airflow diagram of the B-29 Superfortress' pneumatic bomb bay door actuating system.

control of the doors through the salvo circuit. *Aero Digest*, June 1, 1945, pages 70, 71, 243, 4 illus.

Design of Aircraft Lubrication Systems. C. Stewart Brandt. These are the first two installments of a three-part article dealing with various aspects of lubricating-system design. Part I discusses difficulties involved in the installation and functioning of lubricating systems. Complications in the lubricating system which have been induced by the introduction of high-performance aircraft are enumerated. The three basic types of lubricating system in general use, namely, the Army, Navy, and commercial systems, are described and their advantages and shortcomings are analyzed.

In Part II, design factors governing the oil capacity for different types of lubricating systems are discussed. Detailed comments are made about the requirements for lubricating tanks, outlets, venting systems, oil-quantity measuring devices, drain valves, fillers, and immersion heaters. Diagrams show the design of a typical supercharger oil system and a typical feathering-propeller oil system. *Industrial Aviation*, May, 1945, pages 44–46, 48, 50, 89, 8 illus.; June, 1945, pages 24, 26, 27, 30, 31, 93–95, 12 illus.

Which Auxiliary Power—Electric or Hydraulic? Col. T. B. Holliday. The advantages and disadvantages of electric and hydraulic methods of providing power for the aircraft accessory system are studied and compared. Consideration is given to their fields of application and reliability of operation. The requirements for accessories are defined. Other sections of the article discuss the power source, distribution system, power utilization devices, and power storage. Data are presented in the form of charts and tables. *Machine Design*, June, 1945, pages 101–107, 17 illus.

Hose, Clamps and Fittings. Major Raymond C. Pierce. This article describes how experience in the field combined with research work in the laboratories of the Air Technical Service Command have made possible improvements in hose, hose clamps, and fittings for combat and transport aircraft. It is noted that hose leaks that formerly caused forced landings and sometimes the loss of both airplanes and personnel have been largely overcome by these improvements. Recent developments in self-sealing hose, clamps, and fittings for fuel lines, oil lines, and other services are described. Specifications and other data on the subject are included. *Aviation Maintenance*, June, 1945, pages 44–47, 128, 130, 132, 136, 13 illus.

Aerodynamics

A Review of the Aerodynamics of Flight Load Factors in Relation to the Safety Regulations. Hugh B. Freeman. This article reviews briefly the aerodynamics of flight load factors. An equation for the minimum maneuver load factor is proposed for planes in the transport category, based on the gust stalling speed and a "turbulent air maneuvering speed range." For a value of this speed range of 25 m.p.h., this equation yields load factors in good agreement with past experience. Suggested flight tests for the experimental determination of the speed range would answer the question as to whether our load factors could safely be lowered. The equation applies to flapped, as well as unflapped, wings.

It is concluded that the existing formula for maneuver load factors, based on power loading and gross weight, should be abandoned for a more rational equation based on the dominant parameters of the airplane—i.e., wing loading and aspect ratio. A more reasonable lower limit for the maneuver load factor would be that imposed by a horizontal turn at an angle of bank of 60°—i.e., 2.00. This limit could be reached only by airplanes with wing loadings much higher than any now contemplated. *Journal of the Aeronautical Sciences*, July, 1945, pages 320–328, 12 illus.

The Attenuation Method for Compressible Flow Systems. Leonard Michael Greene. The equation of Bernoulli and the condition of irrotationality of an inviscid fluid are combined to give the normal pressure gradient in terms of the local fluid density, velocity, and radius of curvature. In the attenuation plane the space coordinates are replaced by the radius of curvature and the equipotential spacing as the independent variables. When represented on the attenuation plane, the boundaries are the same for either compressible or incompressible flows. A point common to both flows on the attenuation plane will be at different distances from the body in the physical plane, but will be on an equipotential path which intersects the surface of the body at a point common to both flows on either plane.

For simplified flow systems, a relation between the rate of change of radius of curvature along the equipotential path and the local stream channel contraction is obtained. Using this relation, the adiabatic gas laws, and the condition of continuity, the ratio of the pressure gradients in the attenuation plane becomes a simultaneous first order differential equation which is readily integrated.

The critical condition beyond which a shock wave, flow separation, or both, must occur is the failure of a stream channel to contract from the free stream to a negative pressure peak. It coincides with the appearance of a singularity in the solution obtained by the attenuation method and not with the occurrence of the local speed of sound. A theory is presented on the behavior of flow systems having critical or supercritical regions.

Charts are included for the correction of incompressible pressure coefficients to the corresponding compressible pressure

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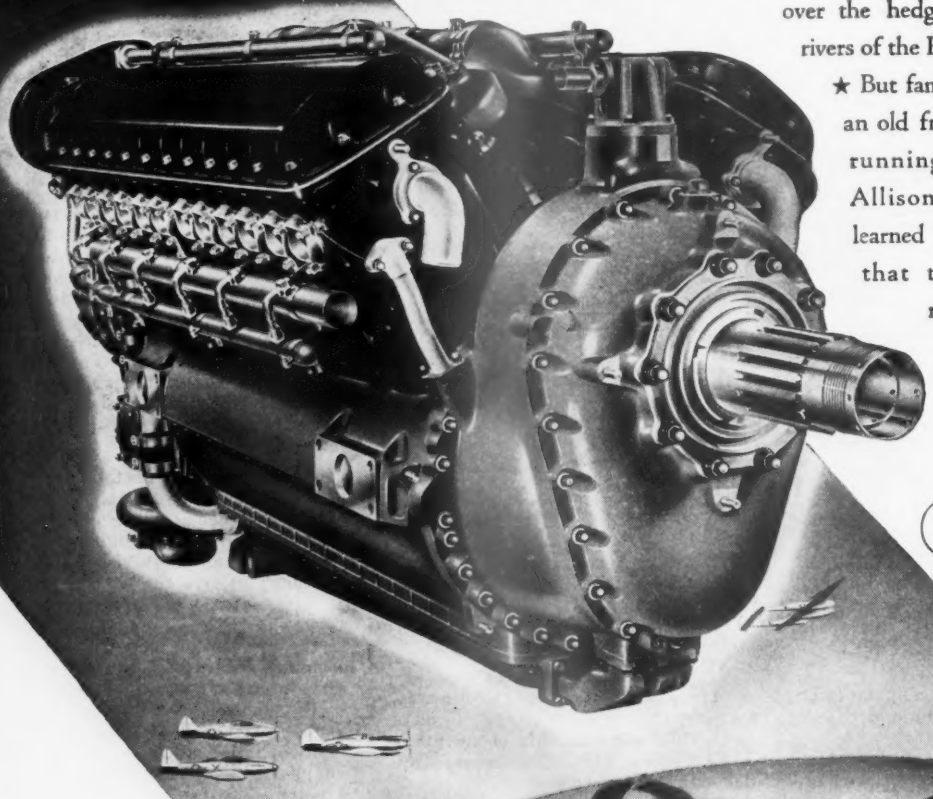
On plane after plane, "rising suns" line up beside "swastikas" as the men and planes that helped smash the Nazis join the fight against the Japs. ★ Strange are the island-dotted open seas to the pilots who earned their "swastikas" over the hedgerows and winding rivers of the European Continent. ★ But familiar as the voice of an old friend is the smooth-running power of their Allison engines. Pilots learned half a world away that the name Allison means quality workmanship—and a reliable, dependable product.



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coefficients for values of the free stream Mach Number up to unity. *Journal of the Aeronautical Sciences*, July, 1945, pages 329–338, 11 illus.

Performance Methods for High-Speed Aircraft. Wallace D. Hayes. This paper presents methods for the calculation of the performance of an airplane when the influence of compressibility must be taken into account. The availability of correct high-speed wind-tunnel data and of engine characteristics in terms of thrust or thrust horsepower is assumed. The problems of rate of climb, maximum velocity, range, and dive histories are considered.

The methods are based on the principle of separating dimensional quantities into a dimensionless parameter times a dimensional quantity that is a function only of altitude. *Journal of the Aeronautical Sciences*, July, 1945, pages 345–348, 1 illus.

Elementary Considerations of Longitudinal Stability. Marion Thomas Hockman. Increasing longitudinal stability requirements within the past few years have indicated the need for a more precise method for computing the longitudinal stability of an airplane while it is still in the design stage. A method for computing power-off stability is presented which considers the effect of the fuselage and propeller on the aerodynamic center. The use of a neutral stability c.g. position is advocated as a criterion instead of specific values of the slope. *Journal of the Aeronautical Sciences*, July, 1945, pages 370–374, 6 illus.

Tailless Aeroplane Control Systems. A. R. Weyl. Problems connected with the development of control systems for tailless airplanes are discussed. The three functions of airplane control devices are defined and the conditions that these functions have to satisfy are listed. Improved and novel control devices that have been built to meet control problems are described. Sections of the article discuss longitudinal control by shifting of the center of gravity, control in yaw, air brakes and related devices, rolling control by lift-spoilers, and flaplike controls. Consideration is given to aerodynamic features of trailing-edge controllers. Past developments in the design of trailing-edge controllers are reviewed. Floating ailerons are also discussed. *Aircraft Engineering*, May, 1945, pages 133–145, 45 illus.

Lofting Problems of Streamline Bodies. Part 23. Roy A. Liming in collaboration with Carter M. Hartley. The twenty-third installment of a serial about the conic system of lofting techniques reviews the advantages of the system, which are stated to include a controlled approach based upon projective or analytic techniques or a combination of the two, as distinguished from other "hit-or-miss" methods, in addition to speed and accuracy. The writers then carry forward a discussion of the projective discriminant and its use in such fairing problems as the tip of an airfoil, a cockpit canopy deck modification, and a wing fillet. It is shown that the projective discriminant affords a convenient alternative to the use of the shoulder plane in the fairing of a streamline shape such as an aircraft fuselage. *Aero Digest*, June 1, 1945, pages 66–69, 6 illus.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Air Power

Lessons of the Air War. Part I. Major F. A. de V. Robertson. First of a series of articles reviewing the developments and changes which were evolved in the technique of air warfare to meet the exigencies of the European phase of World War II. Part I is concerned with how Great Britain was secured as an air base. It analyzes the importance of that security to the ultimate defeat of Germany, describes the position of the Allied air forces in 1939, and then traces events through the Battle of Britain. Attention is called particularly to the fighter planes which played the major role in the defense of Britain and to the tactics that were developed in battle for their most efficient use. The securing of another island base, Malta, is mentioned. *Flight*, May 17, 1945, pages 525–528, 9 illus.

Lessons of the Air War. Part II. Major F. A. de V. Robertson. Continuing a series of articles reviewing the developments and changes which were evolved in the technique of air warfare to meet the exigencies of the European phase of World War II, this article deals with the emergence of offensive air strategy on the part of the Allies. Explaining the purpose and value of strategic bombing, it traces advances in aircraft design, tactics, and armament which made possible the vast bombing raids on Germany preparatory to the Allied invasion of the European continent. A succession of British bombers which marked the progress from the Hawker Hart to current two-engined and four-engined bombers is noted. *Flight*, May 24, 1945, pages 562–565, 10 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Lessons of the Air War. Part III. Major F. A. de V. Robertson. In Part III of this series the gradual maturity of the principle that sea power must be supported by air power is discussed. The increasing importance of the aircraft carrier through the war years, the many ways in which airplanes reinforced sea power, and the cooperation between air and submarine forces are recorded. *Flight*, May 31, 1945, pages 584–586, 4 illus.

Air-Warfare Review. Hanson W. Baldwin. An analysis of events that have taken place during the spring and early summer months of 1945 in the air war against Japan, with an indication of some probable trends that will be followed in the bombing of Japan. It is stated that the best weapon that has so far been developed for the bombing of the Nipponese is the incendiary bomb, while the enemy's most dangerous defensive weapon appears to be the suicide plane.

Among the subjects discussed are: the effectiveness of Superfortresses for low-altitude area incendiary bombing compared with high-altitude precision bombing, the unexpectedly weak defenses of the Japanese, the development of more bases from which to bomb the Japanese, and the possibility of Russian participation in the Pacific war. *Skyways*, July, 1945, pages 19, 88, 1 illus.

Target: Japan. Phillip Andrews. An evaluation of Japan's vulnerability to air attack. Emphasis is placed upon the weakness of Japan's position resulting from the concentration of its industrial and economic forces, with Japan likened to England in its vulnerability to air assault. The types of air equipment and strategy necessary for attack against Japan are discussed. They are said to differ from those required against Germany because of varying weather and distance conditions. *Air News*, June, 1945, pages 17–19, 61, 66, 6 illus.

Bombing Japan's "Backyard." Alexander Kiralfy. An interpretation of the strategic and tactical value of Okinawa's bases in the air war against Japan. Targets that will be within reach from Okinawa, techniques that will be employed by planes operating from there, and the effect of typhoons on the pattern of the war region are considered. *Flying Age*, July, 1945, pages 20, 21, 66–68, 4 illus.

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Air Transport

Air Transport in Pennsylvania. R. Hadley Waters. A survey is reported of past and present, as well as future services to be provided by commercial air-line companies for the cities and towns of Pennsylvania. The first section reviews prewar facilities in the state, giving figures concerning the routes, airports, lines, number of daily trips, and rates of fare. Changes that have taken place in schedules are outlined, bringing the information up to date. The third section discusses postwar plans for commercial air services in the state, with detailed descriptions of the services proposed by United Air Lines, Eastern Air Lines, Transcontinental & Western Air, American Airlines, Pennsylvania-Central Airlines, the Greyhound Corporation, and All American Aviation, Inc. The article is supplemented by maps and statistical tables giving significant figures for the towns served by the different air lines.

A supplement titled "Airport Development for Pennsylvania," contains a brief description of the National Airport Plan. Tables give figures and percentages for population, area, costs, and other data concerning the airport plan. *Bulletin No. 19 of The Pennsylvania State College*, December, 1944.

How to Estimate Costs in Feeder Airline Operations. Part III. James G. Ray. Third in a series of four articles on various phases of feeder airline establishment and operation, this article outlines procedures for estimating both direct and indirect costs of operation. It also advises how to predetermine the potential income against which these costs must be measured. Certain of the major cost items are analyzed and compared with corresponding trunk airline costs, while an indication is given as to which costs can be eliminated and which may be expected to increase in the case of feeder lines. The opinion is stressed that, instead of requiring excessive Government subsidy, the establishment of feeder air lines will prove to be profitable to the Government as well as to the operating company. *Aviation*, June, 1945, pages 110–113, 1 illus.

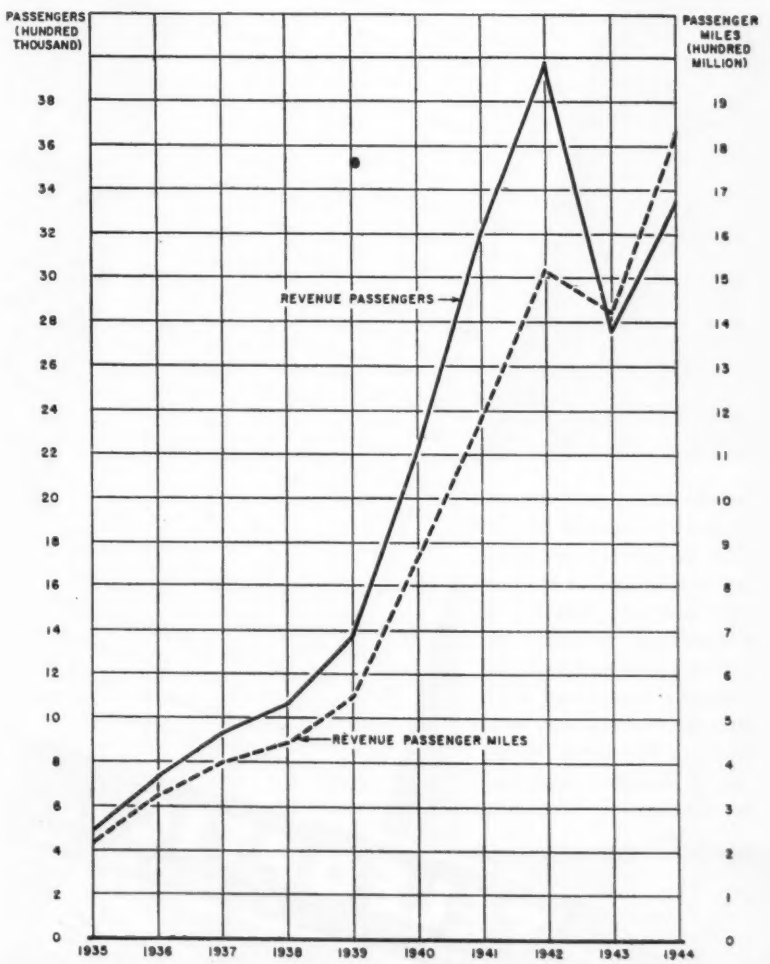
The Railroads' View of Air Transport. Russell B. James. This seventh installment of a symposium on whether surface carriers should be permitted to participate in postwar air transportation takes the affirmative side of the discussion. While stating that he does not believe surface carriers ever will or ever should control aviation, the writer advocates the operation of air routes by surface carriers where it can be demonstrated that such operation will be of benefit to the public. Claiming that the railroads have displaced no hostility toward air transport and have made no attempt to interfere with its development, he also offers reasons for his opinion that the entrance of well-managed surface carriers into aviation would stimulate the progress of engineering and operating techniques.

The writer's contentions are based on three primary considerations: (1) Since the Railway Express Agency has been able to render efficient and economical assistance to aviation, it follows that, where conditions justify it, other surface carriers can do likewise. (2) Past experience with railroad-affiliated motor carriers demonstrates that such operations have been conducted with the single purpose of providing service of high quality at reasonable rates and fares. (3) The experience with railroad-operated air lines in Great Britain has been eminently satisfactory to the public and government. *Aero Digest*, June 1, 1945, pages 50, 51, 138, 140, 1 illus.

British Air Line Pilots at War. David Brice. An outline record is given of the contributions made by British air-line pilots to the successful prosecution of the war. In addition to noting world-wide transport routes that were operated by these pilots for war purposes, the writer also points to the utilization of their experience by the combat services. Several individual pilots who performed outstanding feats are mentioned. *The Aeroplane*, May 18, 1945, pages 577, 578, 1 illus.

The Poor, Poor, Airlines Can Pay Their Way. John H. Frederick. The writer criticizes the schedule of landing fees for air lines as being too low at most airports. Claiming that an examination of the air-lines' profit reports demonstrates that they are well able to pay higher fees, he reasons that raising the airport fees for air lines would not only benefit the airports but would also enable the air lines to avoid the excess profits bracket. A table shows the net profit after taxes of 16 individual air lines for the years 1942, 1943, and 1944. *Southern Flight*, June, 1945, pages 44, 50.

The Future of World Airlines: Belgium. Lucien Zacharoff. A consideration of the future potentialities of Belgian air transportation. Figures are quoted to show that air transport in Belgium was developed virtually to the saturation point before the war, with



Revenue passengers and revenue passenger-miles of domestic air carrier operations for the fiscal years 1935–1944 as shown in the 1944 Annual Report to Congress of the activities of the Civil Aeronautics Board.

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the consequence that future expansion of that country's air activities may be expected to center mainly around the Belgian Congo. *Air Trails*, July, 1945, pages 28, 98–102, 3 illus.

These Traffic Estimates Will Serve Operators and Producers. William Friedman. A method is detailed for the prediction of future air-travel requirements. Applicable to both airline and private flying, the system takes into account the amount of increase in mileage traveled by all means of transportation in addition to the amount of traffic which will be diverted to air travel from other transport mediums. Suggestions are also given for the determination of the number of planes necessary to handle the predicted traffic. Tables and figures which illustrate the calculation method project the estimates to 1950. *Aviation*, June, 1945, pages 174, 175, 261, 262, 265, 266, 268, 2 illus.

Take the High Road. Idell Durrett Hays. A consideration of the problem presented to air transport by the migratory flights of birds. It is related how bird-migration charts aid air-line pilots to avoid the regular flight paths followed by the birds. *Skyways*, July, 1945, pages 31, 68, 70, 4 illus.

Pilot Views Crew Fatigue as a Major Flight Hazard. Francis A. Spencer. The writer discusses the causes of pilot and crew fatigue, and what may be done to eliminate them. The article has particular reference to single-crew transoceanic operations using C-54 equipment but is applicable to domestic commercial operations. It is suggested that the proper authorities give consideration to attempting to run a scheduled operation comparable to that of domestic commercial air lines, and that rest periods of 16 or 32 hours be provided wherever possible. It is stated that crew fatigue may also be considered by the makers of the planes, engines, and accessories. Reduction in noise and vibration level should be goals of the airplane and engine manufacturer, while the design of a wearable oxygen mask; healthful, reliable heaters; comfortable seats; and restful lighting may be problems for the accessories companies. *American Aviation*, June 1, 1945, pages 22, 23.

British Overseas Airways Corporation Routes and Fleet, March 31, 1945. The aircraft owned and operated by British Overseas Airways Corporation, as of March 31, are listed. The tabulation gives the type, registration letters and name, number of engines, and the home base of each airplane. Air routes flown by the B.O.A.C. as of the same date are indicated by a map. *The Aeroplane*, May 4, 1945, pages 522, 523, 1 illus.

In Spite of Difficulties. C. Brunning. The history and operations of Allied Airways, Ltd., are recorded briefly. An idea is given of some of the problems encountered by this British air line in establishing air service in 1934, in meeting competition during the years 1935 to 1939, in being the only British air line to maintain operations in wartime. *Flight*, May 10, 1945, pages 510, 511.

Airplane Descriptions

Heinkel He177. The general design and construction of the Heinkel He 177, German four-engined heavy bomber, are surveyed. The article is based on a brief inspection of the only craft of the type that exists intact in England. Details reviewed include those pertaining to the power plant, fuselage, wings, undercarriage, armament, and cabin. Figures regarding weights, loadings, power, etc., are reported. In an evaluation of the merit of this bomber, it is claimed that, while it embodies various design features of marked ingenuity, the worth of these features in their particular applications is somewhat questionable. *Flight*, May 10, 1945, pages 498–500, 11 illus.; "The Heinkel He177," *The Aeroplane*, May 11, 1945, pages 546, 547, 8 illus., May 18, 1945, pages 571, 572, 6 illus.

The Miles "Aerovan" Aircraft. Some details are given about the Aerovan, a new aircraft introduced by Miles Aircraft, Ltd. It is designed as a light military freighter, with a pay load of one ton, a range of 450 miles, and a cruising speed of 110–115 m.p.h. It is stated that this aircraft can be easily adapted for use as a troop carrier, a passenger-carrying aircraft, an air ambulance or emergency operating theater, an aerial shop or showroom, or a flying caravan. It is a high-wing monoplane, powered by two Gipsy Major or Cirrus Major engines, driving either fixed-pitch or constant-speed propellers. A tricycle undercarriage with a steerable cantilever nose wheel is used. *The Engineer*, June 15, 1945, page 477, 1 illus.

George—The Kawanishi Shiden Single-Seat Fighter. Brief information is given about the Kawanishi Shiden Japanese Navy fighter, which has been developed from the Kawanishi Kyofu floatplane fighter and has been given the code name of George. The new fighter has a slightly lower wing position and an inward retracting wheel undercarriage instead of a float. It is powered by a 2,000-hp. Nakajima Homare 18-cylinder, two-row radial engine. Armament includes two 7.7-mm. machine guns mounted on top of the cowling and two 20-mm. cannon mounted in the wings. It is stated that some versions carry an additional cannon in the bulge beneath the wing. The span is 39 ft. 4 in.; length 29 ft. 4 in. The maximum speed is stated to be about 420 m.p.h. *The Aeroplane Spotter*, May 17, 1945, page 111, 2 illus.

Me 262. From a captured Me 262 Schwalbe which was tested in Britain, a few provisional details regarding the construction of this German reaction-propelled fighter are relayed. These details pertain mainly to the Junkers Jumo 004 gas-turbine units and their installation; the general lines of the airplane; its wings; its undercarriage and wheels; the fuselage; the cockpit; armament; and provisions for carrying fuel. *The Aeroplane*, May 4, 1945, page 516, 6 illus.

Offer Power Option in New Lightplane. Some particulars are given about the Midwest Mercury, a two-place, side-by-side, high-wing light plane, the design of which is reported to be in the experimental stage. It is stated that two models will be produced, a standard model powered by a 65-hp. engine, and a de luxe model provided with a 75-hp. engine. The structure of this light plane is conventional. The wing is of all-metal, single spar, stressed-skin construction. Development of the plane is being carried out by the Midwest Aircraft Company, Wyandotte, Mich. *Aviation News*, June 4, 1945, page 22, 1 illus.

Handley Page Civil Programme. Particulars are given about two aircraft announced by the Handley Page company for postwar civil use. One is a passenger version of the Halifax bomber, the other a freight version of the Hermes. Features of design, accommodation provisions, speed, range, and pay load are among those indicated. Specifications of both planes are listed. *Flight*, May 31, 1945, pages 577–580, 9 illus.; "Handley Page Hermes Civil Cargo Carrier," *The Aeroplane*, June 1, 1945, page 636, 2 illus.; "Halifax Transport Conversion," *The Aeroplane*, June 1, 1945, pages 634–636, 4 illus.

Plane for Tomorrow. D. Newell Ahnstrom. Salient characteristics of the Skycraft Model 445, a postwar light-plane design, are surveyed. Made of an aluminum alloy, except for its steel landing gear and engine mount, the Model 445 is described as a low-wing, twin-boom pusher plane that seats three passengers and a pilot. Wheel control in the cockpit employs a push-pull system, utilizing a shaft working through the instrument panel, and eliminating control sticks. Specifications and performance figures for this plane are listed in the article. *Skyways*, July, 1945, pages 24, 25, 2 illus.

I Flew the P-80!! Col. Bruce Holloway. A report on the handling and performance characteristics of the Lockheed Shooting Star by an Army officer who piloted the jet-propelled fighter. Some of the qualities that the writer cites as having impressed him most are the lack of vibration, the speed, and the maneuverability of this aircraft, as well as the absence of a need for warming-up and of complex controls. Characteristics of the P-80 are contrasted with those of the two German jet-propelled planes, the Me 262 and the Arado 234. *Skyways*, July, 1945, pages 20, 21, 84, 1 illus.

The New Transport Planes. Parts I and II. The first article in a series for laymen gives a description in nontechnical language of recently announced large transport planes. It includes a section giving elementary information and diagrams about the gas turbine and the principles upon which it operates. Other sections of the first installment review the development of large transport aircraft in the decades beginning with 1920 and 1930.

Part II continues a discussion of the aircraft of the future, explaining such developments as the "tear drop" airfoil, laminar-flow wings, and the relative merits of woods, metals, and other materials for aircraft construction. Reference is made to addresses and published matter by leading aeronautical engineers including various Wilbur Wright Lectures and Wright Brothers Lectures. A table gives the comparative weights, passenger capacities, speed, and range of the Boeing Stratocruiser, the Douglas DC-7, the Martin Mars, the Lockheed Constitution, and the Consolidated Vultee Model 37. Reference is made to Hall L. Hibbard's predictions concerning reaction-propelled aircraft. Illustrations include performance charts of typical aircraft, diagrams showing comparative sizes, and cutaway drawings revealing the internal construction of wings and jet propulsion engines. *Fortune*, June, 1945, pages 131–137, 258, 261, 262, 264, 21 illus.; July, 1945, pages 141–145, 168, 170, 172, 174, 177, 12 illus.

The "Winglet" New Lightplane. Some brief details are revealed about the Winglet, a three-place, low-wing airplane that will be built by the Chesterton L. Eshelman Company for the postwar personal aircraft market. With a range of 550 miles and a fuel capacity of 30 gal., the Winglet is designed to cruise at 100 m.p.h. It will be powered by a Franklin 90-hp. engine and will have a fixed type of landing gear. A departure from the conventional in the design of this plane is a wing spar that is tubular in cross section and serves a dual purpose in that it is also employed as a gasoline tank. Specifications for the Winglet are listed. *Aero Digest*, June 15, 1945, page 102, 2 illus.

Vickers Viking. C. B. Bailey-Watson. The design, construction, and performance of the Vickers Viking are surveyed. A postwar civil aircraft intended to seat 21 to 27 passengers, the Viking is reported to be an aircraft specifically designed for ease of production and having excellent pay load and performance for low operating costs. Although in the main it is a structurally conventional aircraft, its new features are reported to include a flexible wing-to-fuselage attachment and a luggage floor in the fuselage which acts as a large "longeron-keel." Its fuselage is of stressed-skin construction, while its wings and tail unit are fabric-covered. Two Hercules 10M engines power the plane. Schematic drawings and tables of specifications and data supplement the descriptive details given about the Viking. *Flight*, May 24, 1945, pages 556a–557, 8 illus.; "Vickers-Armstrongs V.C.1 Viking," *The Aeroplane*, May 25, 1945, pages 597–601, 8 illus.

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Airports and Airfields

Airport Planning for Private Flying. Part I. This article begins a series containing advice about the practical steps to be taken in the construction and development of Class I and Class II airports for private flying. The first article is concerned with the general aspects of the problem and the factors of site selection. The recommendations offered for site selection pertain to eight major considerations: (1) freedom from obstructions or adverse approach conditions; (2) location with respect to other airports; (3) accessibility; (4) meteorologic conditions; (5) topography; (6) access to utilities; (7) soil conditions; (8) economics. *Southern Flight*, June, 1945, pages 42, 43, 50, 4 illus.

From Loss to Profit at Woodrum Field. Jennings Randolph. This article describes the policies and methods by which one municipal airport was able to improve its operations during an 8-year period, so that it progressed from a yearly deficit of $7,000 to an earned annual income of $49,814 above operating and maintenance costs. Eight major policies are summarized. A table of figures indicates the income derived (or funds lost) from Woodrum Field by the Federal, State, and city governments for each of the years from 1937 to 1944. *Airports*, June, 1945, pages 36, 44.

Prefabs Show Real Promise for Postwar Hangarage. Edward E. Thorp. Indicating the advantages of the prefabricated individual hangar, the writer surveys the fundamentals to be considered in their erection and use. In brief detail he discusses their design, foundations, materials, floorings, finishes, and cost factors. A series of drawings illustrates types of prefabricated hangars offered by various companies manufacturing these structures. *Aviation*, June, 1945, pages 170–173, 15 illus.; "All-Steel One-Plane T-Hangars Offer Post-War Shelter Solution," Alexander McSurley, *Aviation News*, June 11, 1945, page 17, 2 illus.

Plan for Lambert-St. Louis Airport. These notes describe the main features in the proposed expansion of the Lambert-St. Louis Municipal Airport. At an expected cost of $4,000,000, the additions will triple the size of the present airport. They will include a modern terminal and administration building connected to a series of unit buildings for each of the five major air lines using the airport. *Aero Dige t*, June 15, 1945, page 69, 1 illus.; "Giant Terminal for Lambert-St. Louis Airport," *Airports*, June, 1945, pages 40, 55, 1 illus.

Airplane Performance and Airport Design. Part II. Frederick K. Teichmann. Second article in a series analyzing the basic factors involved in airplane performance which have a direct bearing on airport location and design. Part II comprises a study of the effects on airport design of gliding angles, speed along the flight path, and height of obstructions. *Airports*, June, 1945, pages 34, 35, 57, 5 illus.; "Influence of Performance Characteristics on Airport Requirements," by Clarence L. Johnson in collaboration with Philip A. Colman, *Aero Digest*, June 15, 1945, pages 56–61, 204, 206, 208, 11 illus.

Dispersal of Fog on Airfields. Parts I and II. These are the first and second installments of a continued article giving particulars about the operation of the "Fido" system of fog dispersal. The article is based on information released by the British Bomber Command and the British Petroleum Warfare Department. It is noted that the name "Fido" was originally derived from Fog Investigation Dispersal Operations, but when the system proved a great success the Royal Air Force named it "Fido," Fog, Intensive, Dispersal Of. Part I outlines the early history of fog-dispersal developments and describes the initiation of the recent investigation, stating the problem involved and giving the suggestions toward its solution made by the Royal Air Force. Methods based on the precipitation of fog-water droplets, and the evaporation of fog-water droplets are discussed.

Part II discusses further engineering and scientific experiments. Information is given about experiments conducted with the "Haigas" and the "Haigill" burners. *The Engineer*, June 8, 1945, pages 452, 453, 1 illus.; June 15, 1945, pages 471–473, 5 illus.

Airports Vital for Short-Haul Airlines. Halsey R. Bazley. The President of All American Aviation, Inc., explains why he believes adequate airport facilities and strategic location of airports are even more essential to the development of feeder lines than they are to major air lines. His explanation considers the fact that proposed routes with large passenger potentials sometimes have to be discarded because of the insufficiency of the airports. *Airports*, June, 1945, pages 27, 54.

Building the Small Airport. Part 5(B). L. C. Vipond. The current installment of this series of articles on various phases of small airport construction further discusses the subject of inexpensive lighting systems. Information is given about multiple and series strip marker lighting systems, and the A.N.C. lighting system for strip-type fields. The advantages and disadvantages of the different lighting systems are listed and discussed. The cost of equipment is also tabulated. Diagrams show the layout of the systems. *Aviation Maintenance*, June, 1945, pages 54–58, 114, 116, 5 illus.

Diversified Airport Operations for Profits! Frank B. Howe. A survey of various operations being conducted on the Class IV Grand Central Airport at Glendale, Calif. Among the activities noted are those of airplane maintenance, engine overhaul, and other service facilities; aeronautical training schools; and a "special devices" factory. Mention is also made of additional operations that will be launched as soon as the war ends. *Airports*, June, 1945, pages 28, 29, 44, 5 illus.

Airport Merchandising. Dudley M. Steele. Continuation of a series of articles investigating individual revenue-producing schemes for airports. This one deals with the revenues that can be derived from fixed-base and charter operations. It offers suggestions with regard to hangar rentals, building rentals, airport ground rentals, electric power sales, and leasing of space to automobile-renting systems. *Southern Flight*, June, 1945, pages 46, 50.

Design and Location of Structures for the Modern Airport. Part I. Hervey F. Law. One of a series of articles presenting the major factors involved in the planning, design, and construction of the many types of landing facilities which will be required for postwar flying. The present article describes an investigation into problems of design and location of airport structures.

Consideration is given to hangars, terminal buildings, ramp facilities, and additional revenue-producing facilities for air travelers' comfort. It is shown that both in the planning of individual structures and in the preparation of a master plan for the entire airport, provision must be made for the ultimate development of the units. Several diagrams of airport and building plans illustrate the discussion. *Aero Digest*, June 15, 1945, pages 70–73, 6 illus.

Cutting an Airpark Out of the Woods. Lincoln B. Farnsworth. A brief account of how a Class I airport was created in a burned-over wooded section adjacent to a Maine town. Information is given about costs and some of the construction problems encountered; future plans and potential revenue sources are outlined; and a diagram illustrates the layout of the two-flight-strips "airpark." *Airports*, June, 1945, page 32, 1 illus.

Avigation

Finding the Navigational Stars. Part VI. Ben C. Kenny. This installment defines the substellar point and the circle of position of which it is the center, as well as the zenith distance and the altitude of a star, all of which are used in the determination of a fix.

The writer then resumes discussion of the recognition of the navigating stars, of which 31 have been identified in previous articles of the series. Four additional stars are taken up in the current section, these being Antares, Dschubba, and Shaula in the constellation Scorpio, and Sabik in the constellation Ophiuchus. The location of each of these stars is described and indicated in the diagram that accompanies the night

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photograph of that portion of the sky in which they appear. *Aero Digest*, June 15, 1945, pages 80, 81, 4 illus.

Let's Simplify Navigation. G. Sidney Stanton. To obviate the necessity of correcting for variation, it is proposed that the design of aeronautical charts be changed by replacing the present isogonic lines with magnetic meridians. The nature of this change is explained; the practicability of making the change is weighed; and the advantages to be gained from it are indicated. Charts help to illustrate the present method of plotting a course, which involves making the measurement and then adding or subtracting the isogonic value, as compared with the proposed system which would consist of measurement only. *Flying*, July, 1945, pages 32–34, 116, 118, 120, 4 illus.

Aircraft Microwave-Beam System. As revealed in the company's application to the Federal Communications Commission, the main points of a microwave relay system planned by the Raytheon Manufacturing Company are outlined. Information is given about the stations that will be established, the frequencies along which they will operate, and the purposes for which they will function. Advantages of such a system to the aviation industry are noted; properties, characteristics, and applications of microwaves are reviewed briefly; and the design and construction of microwave tubes are described. The article also tells about the local airport system of plane location which Raytheon is developing, to be used in conjunction with its continental communications project. *Aero Digest*, June 15, 1945, pages 82–84, 6 illus.

Bearings

Rotating-Load Bearings. Arthur F. Underwood. An investigation is reported of the unaccountable difference found to exist between the performance of a given journal bearing when carrying a load of constant direction, compared with one carrying a load that revolves in direction around the stationary bearing support. From a practical standpoint, this meant that a bearing having a rotating load would support a far greater load than one having a unidirectional load. In addition, a need has existed for a means to measure the friction of a bearing supporting a rotating load. Based on a known phenomenon, an idea was devised to allow the cradling of such a bearing on a frictionless support and at the same time to make it fairly rigid. The writer describes experiments conducted on such a device and presents a new theory of the action of the oil film on a bearing under a rotating load. *Automotive and Aviation Industries*, June 1, 1945, pages 26–28, 60, 64, 6 illus.

Civil Aviation

International Plane Markings. Andre Berniere. An outline is given of the recommendations made at the

International Civil Aviation Conference in Chicago for world-wide standardization of nationality markings on civil aircraft. Indicated as a conceivable model for the international system, the plan followed by the United States for marking its aircraft is explained in detail. The system used by all countries other than the United States is also described, but in briefer terms. A tentative table of letter designations for each country, as submitted to the Chicago convention, is shown. *Flying*, July, 1945, pages 48, 49, 96, 98, 102, 2 illus.

The I.C.A.N. Conference. Z. Ciolkosz. A report on the revival of the activities of the International Committee for Air Navigation in Paris. An outline is given of the current work that has been accomplished with the revision of the Technical Annexes to the Paris Convention of 1919. It is also explained why, with the creation of a new civil aviation international organization, there was a need for the resumption of the I.C.A.N. *Flight*, May 31, 1945, pages 581, 582.

Air Code Report. C. Edward Leasure. The writer discusses the Civil Aeronautics Board as it functions under the Act of 1938. The duties and operations of the board are described in considerable detail. *National Aeronautics*, June, 1945, pages 18, 19, 25, 1 illus.

Building a Profitable Charter Service. Harvey M. Hughes. An experienced operator offers advice on how to expand an airplane-charter business and make it more lucrative. Included are recommendations that airplanes used for charter work be fast, dependable, have ranges of from 800 to 1,000 miles, and be capable of carrying relatively heavy cargo; the pilot must be able to operate independently; and weather should be checked for all parts of the country, instead of merely for the area that is to be covered by a given flight. *Airports*, June, 1945, pages 30, 54.

Salvaging War Surplus Aircraft for Post-War Civilian Use. Russ Brinkley. The many ways in which various components of war surplus airplanes may be used for civilian purposes are noted. Suggestions include nonaeronautical as well as aeronautical applications. However, a large portion of the article is devoted solely to consideration of the instruments that will be available for personal and commercial aircraft at costs far below their value. It is stated that, from war surpluses, it will be possible to outfit a private airplane complete with full instrument-navigation facilities for less than a hundred dollars. *Aero Digest*, June 15, 1945, pages 42, 43, 209, 210, 2 illus.

Australian Boom Hinges on Private Enterprise. H. Bowden Fletcher. A protest against possible government monopoly of Australian civil aviation. It is claimed that nationalization of their aviation industry would be against the best interests of the Australian people because it would stultify the described expansion plans of several industrial groups. The plans noted include those of Qantas Empire Airways, Ansett Airways, Australian National Airways, an unnamed company contemplating lighter-than-air service between Australia and the United States, a proposed service from Australia to China via the Dutch East Indies, and the Commonwealth Aircraft Corporation. *Aviation*, June, 1945, pages 109, 259, 260, 1 illus.

Switch to Flying for Business' Sake! F. R. Gaylord. A report of the advantages that were derived by a trucking and warehousing company from the use of a plane in its sales and administrative operations. Fixed, variable, and total expenditures of operating the plane are tabulated in a cost analysis. *Southern Flight*, June, 1945, pages 30, 31, 2 illus.

Control Equipment

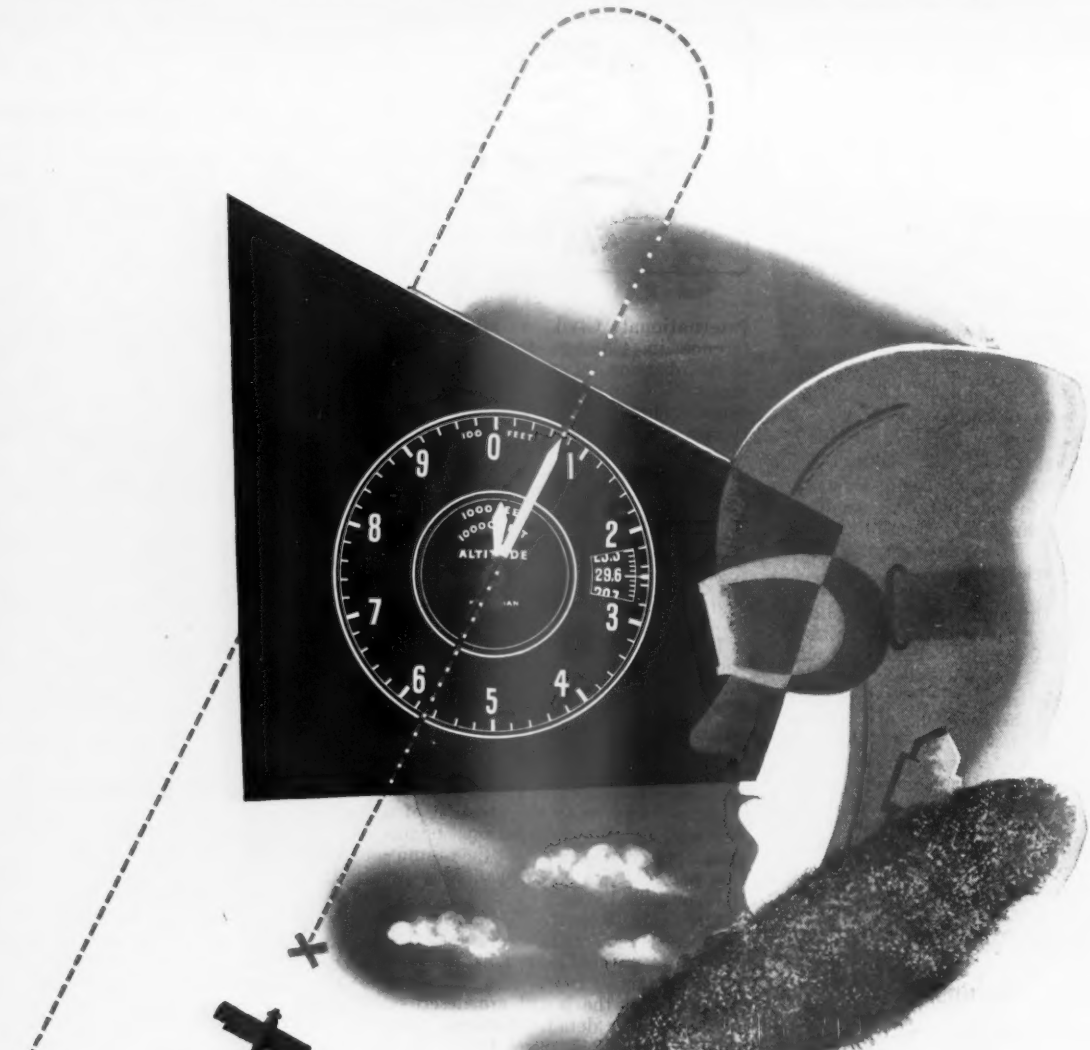
Operational Methods in Servomechanism Design. William E. Restemeyer. An important class of automatic control devices whose use is not restricted to any one field is that known as servomechanisms. Defined technically, a servomechanism is an automatic control system having a controlling element actuated by some function of the difference between the actual and desired response of the controlled element. By the use of operational methods in handling physical transients, the servo systems are readily analyzed and quantitative design characteristics are obtained.

It is the purpose of this paper to show the use of the Laplace transformation in the analysis and design of servomechanisms. The treatment is divided into three main parts: (a) the fundamental theory of servomechanisms; (b) the Laplace transformation; and (c) application to a simple servomechanism.

Because of military secrecy, the most interesting applications are restricted and cannot be treated publicly. For this reason, the subject matter of this paper is based entirely on accessible publications and the example chosen is typical of applications in various fields including the military. *Journal of the Aeronautical Sciences*, July, 1945, pages 313–319, 6 illus.

Design

Low-Wing Personal Plane. Richard G. Naugle. The second half of a two-part study of the fundamentals involved in the design of a low-wing pri-



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vate aircraft is concerned with the structural and economic considerations that must be taken into account in the manufacture and marketing of this type of plane. It offers specific examples of aircraft assemblies that achieve the required interrelationship between structural-mechanical arrangements and production units that can be marketed inexpensively. Considerations of function, equipment installation, enclosure and top-deck design, and nose-wheel installation are among those investigated. *Western Flying*, June, 1945, pages 40, 41, 96, 98, 100, 8 illus.

Designing Tomorrow's Personal Plane. Part I. Ralph H. Upson. Introducing a series of articles dealing with the various design problems involved in developing a light plane for the postwar private-aircraft market, this article contains recommendations for the basic approach to such a project. It discusses the engineering factors that must be taken into consideration when designing for performance, safety, and economy. *Aviation*, June, 1945, pages 119–121.

Engineering Problems in Small Aircraft Design. Willis M. Hawkins, Jr. The writer discusses problems connected with laying out the design of a small transport plane for use in interurban operations on pioneer air lines. Design problems peculiar to the small transport plane are evaluated. Solutions are suggested for making this type of plane more economical to operate. Attention is given to take-off requirements, landing-distance regulations, the selection of airplane size, and aerodynamic problems. *Industrial Aviation*, June, 1945, pages 46–48, 50, 96, 97, 9 illus.

Generation of American Fighters. Martin Caidin. Continuation of an article that traces the evolution of American naval fighter planes. Among the naval fighters reviewed in this second installment are the Bell Airabonita; the Brewster Buffalo; Grumman Wildcat, Hellcat, Tigercat, Bearcat, and Skyrocket; and the Vought Corsair. *Air News*, June, 1945, pages 24–26, 66, 68, 7 illus.

Air Progress. Part I. Douglas Rolfe. A group of drawings illustrates the evolution of single-seat fighter planes. American, French, English, and German fighters introduced during the period from 1914 to 1919 are shown in this first part of a continued article. *Air Trails*, July, 1945, pages 38, 39, 19 illus.

Design Analysis of the Grumman F6F-5 "Hellcat." Moss Ringel. Design features of the F6F-5 version of the Grumman Hellcat are analyzed. The six principal refinements incorporated in the new Hellcat are listed. Information is given about the construction of the nose, fuselage, wings, and empennage. Schematic diagrams of the fuel-transfer systems and the carburetor induction system are included. Drawings and photographs of various components and major assemblies are shown. *Industrial Aviation*, June, 1945, pages 7, 8, 10, 12–14, 16, 18–23, 20 illus.

Design Details of Aeronautical Products, Inc. Helicopter. Chester S. Ricker. Numerous sectional drawings supplement this analysis of the NX-1272 Helicopter. Design and constructional details include those pertaining to the aircraft's fuselage, cabin, landing gear, engine, rotor, power transmission system, and controls. A summarizing evaluation of this helicopter cites it as a flying laboratory, built solely to test theories and to determine the most efficient means of building a stable, easily controlled craft that can be marketed at a reasonable price. *Aviation*, June, 1945, pages 122–130, 15 illus.

Designing a Boom Tail Pusher Plane. Part I. R. G. Naugle. First part of an article investigating the design problems of a pusher-type personal airplane incorporating booms for the support of tail surfaces. With the advantages and limitations of this type of plane indicated, the problems of designing it are classified according to five main considerations: (1) safety and psychologic factors; (2) basic layout limitations; (3) structural; (4) aerodynamic; and (5) manufacturing. Each consideration is shown to involve the problem of weight and the question of cost. All factors are discussed with the exception of manufacturing considerations directly related to structural problems. *Aero Digest*, June 1, 1945, pages 106, 107, 110, 232, 234, 5 illus.

Short Shetland. A comprehensive review of the design and the structural, aerodynamic, performance, and accommodation features of the Short Shetland flying boat, stated to be Britain's largest aircraft. The qualities that endow this transport aircraft with long endurance in combination with great carrying capacity are particularly stressed. Of the several possible arrangements of the carrying space, the 40-seat, 24-berth version is dealt with in this survey as the most representative. Among the features that are detailed are the hull form of the Shetland; range, pay load, and take-off; flight deck layout; accommodation arrangements; possibilities for private suites; and refreshment provisions. A cutaway drawing of the complete aircraft, as well as tables of data, weights, and dimensions, are included with the article. *Flight*, May 17, 1945, pages 529–534, 8 illus.; "The Short Shetland," *The Aeroplane*, May 25, 1945, pages 602, 603, 4 illus.; "The 'Shetland' Flying Boat," *Engineering*, May 18, 1945, page 395, 1 illus.; "The 'Shetland' Flying Boat," *The Engineer*, May 25, 1945, page 418, 3 illus.

Naval Reconnaissance Fighter. The first half of a two-part article investigating the features of the Fairey Firefly gives a description of the general construction of the plane. In addition, this installment discusses particulars of the Firefly's fuselage structure, center section, and outer wing sections. Chief among the several schematic drawings that amplify the descriptions is a two-page cross section of the entire aircraft, identifying its various components and accessories.

The concluding portion of the survey is concerned mainly with the following features of the plane: flap construction and actuation; tail unit; power plant and accessory services; cockpit layout. Flying characteristics of the Firefly are described briefly. Figures on dimensions, areas, and weights are listed, while several of the discussed components are illustrated by drawings and photographs. *The Aeroplane*, May 4, 1945, pages 517–521, 11 illus.; May 11, 1945, pages 550–553, 10 illus.

The XR-1A Helicopter. John Tassos. An extensive analysis is given of the design and construction of the Platt-LePage XR-1A twin-rotor helicopter. After brief comments about the general form of the craft and its performance, details are given concerning the transmission-gear box, the engine-cooling system, the power plant and its driving and control mechanisms, and the flight controls of the aircraft. Its functions in military service are summarized. *Industrial Aviation*, May, 1945, pages 7, 8, 10, 12–14, 16, 15 illus.

Fundamentals of Aeroplane Design. A. L. Klein. It is noted that the three underlying fundamentals of aircraft engineering which must influence every design decision are safety, weight, and serviceability. The importance of safety and weight and problems of serviceability and manufacturability are discussed. It is stated that, since every device and part known to man will fail sooner or later, it is imperative that the designer make such failures noncatastrophic. Thus landing gears need auxiliary lowering means, brakes need stand-by power, and every engine has two magnetos. Consideration is given to the effects of weight in aircraft. Some representative figures for use in calculating the value of weight in commercial aircraft are listed. It is noted that the weight of any item in an aircraft, however small, is important. A rough weight analysis of a modern transport plane is presented to show that the weight of small items is relatively more important than the weight of large ones. *Aircraft Engineering*, May, 1945, pages 146–148, 4 illus.

The Roadable Airplane. William B. Stout. Indicating certain engineering and design problems involved in the construction of an efficient roadable plane, the writer discusses an approach to the solution of these problems. He states that the development of the roadable plane must emerge from basic assumptions differing from those connected with the development of the conventional airplane. Four wheels and no variation of horizontal flight are two of the factors that he claims must be incorporated in the roadable aircraft. The Spratt "controllable wing" developments and features of the Gwinn Aircar are cited as innovations that offer roadable possibilities. *Air Facts*, July, 1945, pages 28–30, 32–34, 3 illus.

Spartan Executive Model 7-W. Design and constructional details of this five-place, low-wing, all-metal personal airplane are reviewed. Particulars dis-

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cussed include those pertaining to the fuselage components; wing sections; flaps; control systems; empennage structure; landing gear; engine and engine mount; fuel system; and accessories. The analysis is supplemented by a list of the aircraft's specifications and several schematic drawings. *Aero Digest*, June 15, 1945, pages 62–66, 112, 10 illus.

Electrical Equipment

Aircraft Lighting. Col. T. B. Holliday. This article is confined to the external lighting of aircraft. To aid in an understanding of the problems encountered in the design of lighting equipment, the principles of lighting are reviewed. A chart shows the effect of voltage on the characteristics of incandescent lamps. The characteristics of typical lamps are tabulated. Information is given about the various types of lamp bases used in aircraft service. Reflector design is discussed. Consideration is given to the installation of lights on aircraft and the effect of the position of the light beam on visibility. *Industrial Aviation*, June, 1945, pages 34, 36–38, 97–99, 10 illus.

Vibration Insulation and Structural Rubber. J. A. Connon. Written for the engineer concerned with the protection of delicate electric and electronic devices used in aircraft and other war equipment, this is a compilation of information about the fundamentals of mechanical vibration and the properties of structural rubber. It is based on a study of a large volume of existing data of importance in the solution of instrument-mounting problems. *Electrical Engineering*, June, 1945, pages 324–329 (Transactions), 19 illus.

The Dynamotor in Gunfire Control. L. L. Ray. A discussion of the apparatus used in the gunfire-control system of the B-29 begins with the reasons for the selection of the 400-cycle a.c. circuit, using power converted from the 24-volt d.c. primary power system of the plane. The 400-cycle motors were chosen because they provide the desired synchronous speeds of 8,000 to 12,000 r.p.m. with the best combination of weight and size. The writer explains the reasons for the selection of the dynamotor for the conversion apparatus, based on consideration of the ratio of weight to output and other factors, and the advantages thereby obtained. Although certain disadvantages are present in the performance characteristics of the dynamotor, the control equipment was so designed as to offset them. The construction and operation of the dynamotor are explained. The illustrations include cutaway and "exploded" photographs of the dynamotor, a diagram of the connections, and curves of the voltage regulation and frequency output. *Aero Digest*, June 1, 1945, pages 104, 105, 136, 4 illus.

These Connection Techniques Solve Aluminum Cable Problems. Julian Rogoff. Problems encountered in obtaining reliable, low-resistance connections with aluminum cable in aircraft electrical wiring are described, and methods for overcoming these difficulties are detailed. It is explained how surface treatment of the aluminum connectors and proper installation practices eliminate the effects of injurious oxide film, corrosion, vibration, etc. Summarized, the precautions recommended are as follows: (1) Skin cable end carefully, to avoid nicking of strands. (2) Do not splay or misshape strands. (3) Do not remove zinc-petrolatum compound from connector barrel. (4) Insert bared cable end into connector barrel. Hold inspection hole in back end of barrel closed (with finger) to force zinc-petrolatum compound between cable strands. (5) Indent connector onto cable end, making certain that correct dies for use with aluminum cable are employed. *Aviation*, June, 1945, pages 134–137, 271, 272, 7 illus.

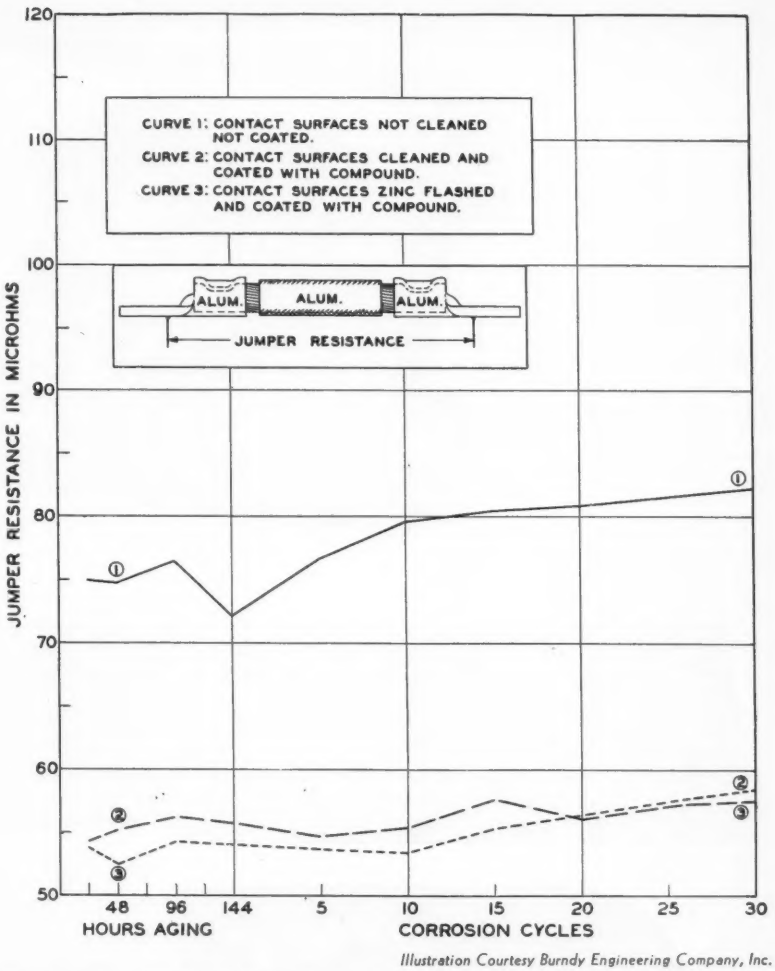


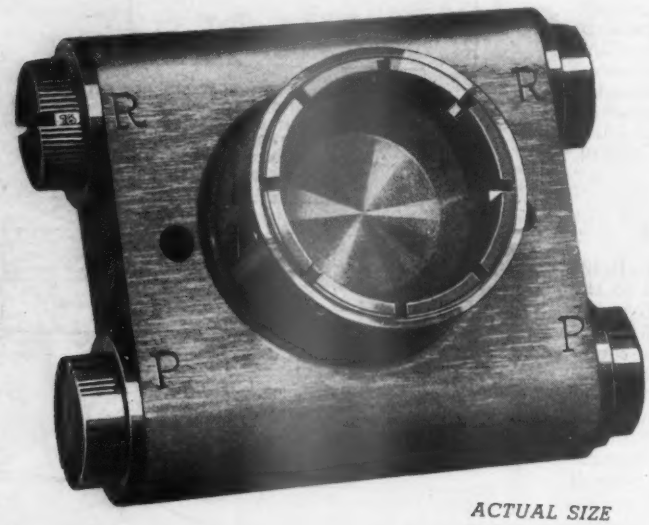
Illustration Courtesy Burndy Engineering Company, Inc.

This chart shows the effect of different connection techniques in obtaining reliable low-resistance connections with aluminum cables in aircraft electrical wiring.

Electrolytic Corrosion—Methods of Evaluating Insulating Materials Used in Tropical Service. B. H. Thompson and K. N. Mathes. The effect of moisture conditions in the tropics on the insulating materials used in aircraft electrical apparatus and elsewhere is described. Means for reproducing such conditions in the laboratory are considered. The visual, corrosion-current, and water-extract conductivity methods for studying electrolytic corrosion are described. Typical results for a number of different materials are given. *Electrical Engineering*, June, 1945, pages 295–299 (Transactions), 10 illus.

Aircraft Electric Systems. Part VII. Francis S. Nelson and G. C. Close. The seventh section of a serial article discusses maintenance and the work of the maintenance specialist. Dividing the work of aircraft electrical maintenance into its three phases of visual inspection, testing, and replacement or repair, the writers review the causes of failure and the steps to be taken to guard against failure of insulation, terminals, fastenings, conduit, batteries, coils, switches, generators, and other instruments and equipment. Detailed instructions are given for inspecting and testing a wide variety of aircraft electrical devices. The need for thorough periodic inspection is emphasized. *Western Flying*, June, 1945, pages 71, 72, 74, 4 illus.

Parallel Operation of D-C Aircraft Generators. R. W. Papenhausen.



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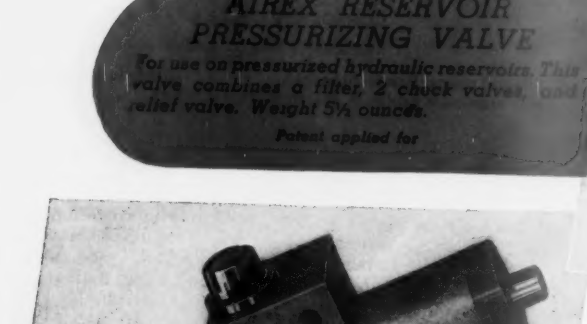

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Requirements for the successful parallel operation of d.c. generators for aircraft are discussed. It is noted that satisfactory parallel operation depends on a reliable automatic voltage regulator, proper design of the electrical system, and careful installation. Each of these factors is discussed in some detail.

Particular attention is given to regulator performance. Among the subjects considered are the basic operation of voltage regulators, the range of regulating action, and regulating adjustments. Both the Army and Navy methods of paralleling are shown by diagrams. *Industrial Aviation*, June, 1945, pages 56, 58, 59, 100, 101, 6 illus.

Engines

A Vibration Theory Combining the Dynamic Stiffness and Mobility Methods. Hugh B. Stewart. Two new methods for calculating vibration problems—the dynamic stiffness method and the mobility method—have been introduced in recent years. Each of these methods offers certain advantages over the older vibration theory. This article is an attempt to unify these two methods so that the best features of each are included in one theory. By means of this theory it is possible to determine the resonance and antiresonance frequencies and the relative amplitudes of vibration of a mechanical system. The effect of the position of torque application on the vibration characteristics of a system are discussed. The application of the theory is demonstrated by a few examples including the problem of the pendulum damper. *Journal of the Aeronautical Sciences*, July, 1945, pages 349–355, 9 illus.

Turbine Compounding with the Piston Engine. C. F. Bachle. The writer suggests a compound engine, consisting of a piston engine mechanically connected to a turbine, with the turbine receiving the piston-engine exhaust as a method of converting into useful work some of the exhaust-gas energy of both Diesel and gasoline engines which is usually wasted. Compound engines with various compressor and turbine combinations are illustrated diagrammatically and discussed. In all arrangements where the air compressor is between the turbine and engine, torque is received by the end of the crankshaft opposite to the propeller instead of torque leaving from this end for the compressor drive. The combination of a gasoline piston engine compounded with a gas turbine and driving a propeller is considered by the writer to offer the minimum weight of power plant plus fuel for long-range aircraft cruising at 300 m.p.h. For short-range cruising at 300 m.p.h. the gas turbine and propeller combination is considered best, with the gas turbine driven by jet propulsion offering the next best possibility. Only when higher speeds become more practical, as a result of reduced aircraft drag, does the writer believe that piston engines may be replaced by jet-propulsion turbines. *SAE Journal*, June, 1945, pages 345–351 (Transactions), 8 illus.

Hercules 10M. Particulars of the HE-10M version of the Bristol Hercules 14-cylinder sleeve-valve engine are revealed. The description emphasizes those features of the engine which contribute to an achieved combination of high performance with economy of operation. Details are given about the fuel and ignition systems; bearings; reduction gears; crankshaft and crankcase; cylinders; sleeve valves; supercharger; oil sump; induction pipes; engine accessories, etc. Charts, graphs, tables of data, and drawings amplify the description. *Flight*, May 24, 1945, pages 558–560, 7 illus.

Better Piston Rings from Wartime Experience. Joseph Geschelin. This is a general review and discussion of recent developments in the design and construction of piston rings for internal combustion engines, including aircraft engines. It is noted that, despite the extensive research work that has been carried out, there is no simple or exact formula for fitting a ring to an engine design. Some factors that exert an influence on the selection of an ultimate ring setup are mentioned. It is stated that progressive improvement in the design of piston rings has resulted from advances made in metallurgy, surface treatments, surface finish, machine-shop practice, and quality control. Some specific examples of developments in ring design are cited. *Automotive and Aviation Industries*, June 1, 1945, pages 32, 94, 96, 100.

Engine Cleaning. Details are given about a machine that is used by the Bristol Aeroplane Company for cleaning aircraft-engine components. Credited with effecting substantial savings in both time and labor, this machine operates on the endless-chain principle. It contains 13 adjustable carriages that carry any engine part through chambers where it is washed by a solvent spray and dried by compressed air in a period of 45 min. *Aircraft Production*, June, 1945, pages 259, 260, 5 illus.

Alcohol-Water Injection. A. T. Colwell, R. E. Cummings, and D. E. Anderson. Reference is made to recent successes with the use of water injection for increasing the power of aircraft engines, which have renewed interest in what is really an old idea. It is noted that recent tests indicate that the injection of alcohol or a mixture of alcohol and water, instead of water alone, gives superior results in many cases. Information is given about an extensive test program, the results of which have led the writers to believe that alcohol-water injection has a field of use in both aircraft and ground-vehicle engines, where it can give more power and smoother operation, with a fuel of about twelve octane numbers less than the normal engine requirement. An automatic alcohol-water injection device that has recently been developed is described. *SAE Journal*, June, 1945, pages 358–372 (Transactions), 20 illus.

Voisin 42-Cylinder Engine. Some details are given about a Voisin liquid-cooled, 42-cylinder, six-row radial aircraft engine having many innovations in design, which is being developed by Société des Aéroplanes G. Voisin. It is stated that the engine is designed for an output of 2,000 hp. at 3,000 r.p.m. and has a specific weight of 0.88 lb. per hp. Information is given about the special design of crankcase, the aluminum cylinder blocks with interchangeable cast-iron liners, the epicyclic gear drive, the crankshaft, which is forged in two sections for each three-cylinder rows, and other features. The master connecting rods have roller big-end bearings with the roller movement controlled by epicyclic gearing. The crankshaft also is supported on roller bearings. Fuel is injected directly into the cylinders by seven 6-cylinder injection pumps. *Interavia*, May 11, 1945, pages 9, 10.

Forecasting Aircraft Propulsion. Colin Carmichael. This is an article written for the purpose of stimulating thought on fundamental problems of aircraft propulsion. Engineering trends are discussed. New developments, such as the gas turbine, jet propulsion, and rocket propulsion, as well as the conventional engine-propeller arrangement, are evaluated in terms of their suitability in particular fields of application. Charts show how the thermal efficiency of gasoline engines varies with the compression ratio and fuel-air mixture, and the way that the thermal efficiency varies with the maximum cycle temperature and with the pressure ratio. A schematic diagram illustrates how a gas turbine may be used to drive a propeller and to furnish a jet in addition. *Cleveland Engineering*, June 7, 1945, pages 7, 38–42, 6 illus.

Detonation in Flight: Its Effect on Fuel Consumption and Engine Life. Philip J. Costa. Flight tests are described which substantiate the results of former research that indicated substantial fuel waste can be safely eliminated when M.I.T.-Sperry detonation equipment is used for limiting detonation by adjusting fuel mixtures. The new tests described also indicate that light detonation, commonly known as "trace knock," has an insignificant effect on engine life. These tests were conducted because it was realized that before the radically new method of mixture adjustment could be advocated it was essential to determine if significant structural damage would result from this method of operation. *SAE Journal*, June, 1945, pages 321–332 (Transactions), 34 illus.

Flight Operations

A New Angle on Long-Range Cruising. Parts I and II. Capt. S. T. B.

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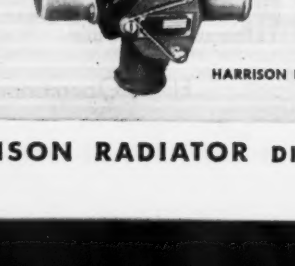

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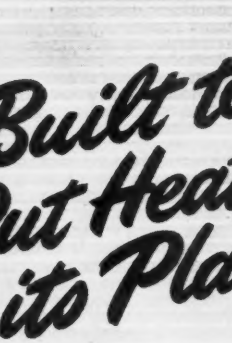

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Cripps. The first part of a study of cruise-control methods gives detailed directions for constructing charts from which fuel consumption, speed, range, and other factors can be determined. The writer reviews and defines the three common procedures designated as (1) constant-power operation, (2) constant indicated air speed, and (3) maximum range. He starts with three lines plotted on a chart showing true air speed against time, establishing the maximum allowed cruising b.hp., the maximum range, the performance limit, and the cruising performance area at the given altitude. To this he adds, step by step, with a thorough explanation of each step, lines for constant true air speed, average ground speed with zero wind, reduction in gross weight as fuel is consumed, route mileage, wind components, and other factors. It is shown that from the completed charts accurate estimates can be made of the performance of a given airplane and its ability to complete a specified flight with an adequate reserve of fuel. Provision is made for head winds or tail winds and other contingencies. An example is given of the estimation of the performance of the airplane on a flight from London to Montreal via Reykjavik, with tabulated data for flight time, fuel used, and average head-wind component. For the purposes of the article, a postwar design of commercial airplane of given specifications and a cruising altitude of 10,000 ft. are assumed, but the method and the charts can be applied to any type of aircraft and any altitude.

The second part connects the cruising data as shown in the charts with direct flying costs, to obtain an even more complete picture of the influence of wind components and how they may be overcome. A comparison is made of direct flying costs under the constant-power procedure and the maximum-range procedure, with tables showing the relative figures and charts giving the application of the cost factors to the other data previously developed. Figures are given for the differences in cost for the London to Montreal flight. *The Aeroplane*, May 11, 1945, pages 542–545, 7 illus.; May 25, 1945, pages 606–610, 4 illus.

Flight Technique

That Last Mile. Wolfgang Langewiesche. Advice is given to the pilot about the last mile when approaching the airport on instruments. The rules formulated are based upon the ideas of an instrument instructor at Sundorph Aeronautical Corporation, to which the writer has added his explanations and observations. As summarized, the rules are: (1) Don't be afraid to take off your corrections. (2) Near the station, keep your corrections small. (3) It is better to miss the cone of silence altogether and pass the station on a correct heading, than to hit the cone while on an incorrect heading. (4) Listen for a pure A or a pure N to warn you that you are about to pass the station. *Air Facts*, July, 1945, pages 46–54, 7 illus.

Flight Testing

A Consideration of Calculated Versus Flight Test Take-Off Performance. M. H. Kiehle and A. Vantine. Theoretic methods for calculating the ground run, transition, and steady climb distances during the take-off of an airplane are derived. The velocity for minimum take-off distance over a 50-ft. obstacle is clearly indicated. A series of approximately 40 take-off tests were made on a C-46 airplane. The technique for measuring and recording the test results and the presentation of the final data are described.

The test data are compared with the theoretic calculations. It is shown that not only the actual minimum take-off distances but also the effect of flap deflection and velocity on the total take-off distance can be accurately predicted by the theoretic methods. The relative effects of C_L, C_D, thrust, ground proximity, ground friction, and other variables on take-off distance are discussed, and the pilot technique derived for minimum take-off is stated.

Finally, it is shown that the complete take-off characteristics of an airplane may be obtained from a short, well-planned test program, with the emphasis placed on determining the maximum accelerations acting on the airplane rather than on testing for minimum distances. *Journal of the Aeronautical Sciences*, July, 1945, pages 263–272, 14 illus.

Effect of Pressure Variations on Speed Runs. Richard M. Head. Inaccuracies in flight-test data obtained from speed runs may arise from the fact that runs made at a constant pressure altitude, constant power, etc., are actually not at level flight conditions because of pressure fields and their movements in the atmosphere. Curves show the magnitude of the error involved for certain atmospheric conditions. *Journal of the Aeronautical Sciences*, July, 1945, pages 311, 312, 319, 3 illus.

Fuels

Fuels and Engines for Higher Power and Greater Efficiency. C. F. Kettering. The writer describes investigations of the effect of molecular structure on fuel knocking characteristics which have led to the discovery and quantity manufacture of the paraffin hydrocarbon known as triptane. It is noted that this fuel is capable of greatly increasing the permissible output of engines with a high degree of supercharge and is also capable of permitting the attainment of higher efficiencies through the use of higher compression ratios. Some remarks are made about research work that is being directed toward finding the best combination of engine and fuel to give the greatest value per total dollar irrespective of what form the engine may take. *SAE Journal*, June, 1945, pages 352–357 (Transactions), 5 illus.; "Superfuels," Peter Franklin, *Air Trails*, July, 1945, pages 24, 25, 64, 66, 68, 69, 2 illus.

Gliding and Soaring

The Commercial Cargo Glider. Richard H. Rush. The writer outlines certain of the operational advantages of the cargo glider by a comparison of the costs of such a craft with an airplane. The possible operational advantages are summarized as (1) overall shipping costs that are less than those by surface carrier or by airplane; (2) overall speed comparable with that of airplanes; (3) transportation service made possible by glider pickup where no other air or surface transportation is available. Inherent advantages over other modes of transportation are reviewed, with emphasis on the economies to be effected, and the conditions favoring glider service are specified. *Soaring*, May-June, 1945, pages 2–5, 15, 3 illus.

Airplane Towing Rules. Randy Chapman. A plea is made for the reconsideration and revision of Civil Aeronautics Administration regulations governing the towing of gliders by airplane. The writer reviews what, in his opinion, are hindrances in the regulations and offers answers to the objections that are generally raised against using airplanes for towing. His suggestions are summarized as follows: Revision of CAR 60 to permit single towing of gliders that are certificated for such operation. Responsibility for the towing equipment shall be placed with the pilots, who must be of private grade or higher and hold ratings in the equipment being flown, and who must have a minimum of 200 hours of logged time in the case of the tow pilot. The minimum tow rope length shall be 200 ft. No requirements for the wearing of parachutes shall be included. *Soaring*, May-June, 1945, pages 6, 7, 13.

The Future of Motorless Flight in Canada. J. A. Simpson. The history of gliding in Canada is outlined. Mentioning the lack of sponsorship accorded gliding and soaring in Canada during past years, the article goes on to relate how the soaring program is being promoted at present and predicts the further development of motorless flight in the near future. The formation of the Soaring Association of Canada is described, as are the purposes, regulations, and activities of this Association. Methods of stimulating gliding training by means of gliding clubs are explained, with this system indicated as the most likely one to be adopted in Canada. The assistance given the Soaring Association by the Civil Aviation Branch of the Department of Transport and the Royal Canadian Flying Clubs Association is reported. *Canadian Aviation*, June, 1945, pages 80, 81, 105, 107, 109, 2 illus.

High Altitude and Distance. Jerzy Illaszewicz. Interesting possibilities for high-altitude flying are reviewed. The main types of vertical currents encountered at altitudes from 7,000 to 30,000 ft. are summarized as (1) pure thermic lift, (2) cumulus energy currents, (3) thermal storms, (4) various kinds of air waves. The writer outlines the special equipment required for

the glider, and the piloting skill necessary for this type of soaring. Advice is given about the precautions to be taken in such flying, with reference to both altitude and distance. *Soaring*, May-June, 1945, pages 11, 13.

No Field? No Fly! Otto Hoefner. Advice is given concerning the selection of sites from which to conduct gliding and soaring operations. The experience of the writer is outlined for the guidance of others who desire to engage in such activities. *Soaring*, May-June, 1945, pages 12, 13.

Hydraulics

Aircraft Hydraulic Systems. S. M. Parker. The Chief Engineer of the Lockheed Hydraulic Brake Company, Ltd., explains why he believes hydraulic methods should be combined with electric devices in the operation of ancillary power systems for aircraft. Contending that an all-electric or all-hydraulic system is appreciably less efficient than a combination, he outlines the governing factors that have to be taken into consideration when incorporating hydraulics into the power scheme. Merits of hydraulic operation are indicated, while evidence is offered that the vulnerability of a hydraulic system in a military airplane can be reduced to a minimum. *Aircraft Production*, June, 1945, pages 301, 302.

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Inspection

Magnesium Alloy Aircraft Casting Inspection. Robert Taylor. The importance of thoroughly inspecting magnesium-alloy aircraft castings following the surface coating operation is emphasized. It is explained that gas bubbles entrapped below the surface of the casting are often protected by a tough skin from the effect of the sand blast. The writer describes a method of distinguishing color patches following a chrome-pickle treatment, which leads to the detection of such cavities. *The Iron Age*, June 7, 1945, pages 63, 142, 1 illus.

Dynamic Inspection Method of Checking Bearing Tolerances. Richard McKendry. The writer describes the principles underlying the dynamic tolerance method of testing bearings for initial friction, end play, and wobble. The new method, which, it is noted, is a radical departure from established inspection methods, is based on the direct system of measuring radial, axial, and torque tolerances. Particulars are given about the testing machine, auxiliary apparatus, and test procedure. *Product Engineering*, June, 1945, pages 372, 373, 2 illus.

Instruments

Postwar Outlook for Aircraft Instruments. Esther H. Forbes. First part of a continued article surveying the possible applications of wartime developments to postwar aircraft instrumentation. The point is stressed that improvements in existing instruments and reductions in their costs have arisen from war research and will be used for the benefit of both the commercial air line and the private flier after the war. Specific instruments discussed include the true air speed indicator, gyrostabilized magnetic compass, flight analyzer, radio locator, precision barometer, sensitive altimeter, helicopter air speed indicator, and helicopter tachometer. The survey is based on information having particular reference to instruments manufactured by the Kollsman Instrument Division of the Square D Company. *Southern Flight*, June, 1945, pages 34, 35, 40, 4 illus.

German Compass Redesign. James T. Blakistone. An account of how a captured model of a German compass was redesigned for use in American airplanes. The compass, a remote-indicating magnetic type operating on d.c., was altered to conform to Army-Navy dimensional standards, operating on 24-volt d.c. and using a three-wire and ground-return circuit of the same kind as employed with a conventional 400-cycle a.c. remote-indicating compass. Particulars are given about the construction and operating principles of both the original transmitter and receiver and the redesigned ones. Improved characteristics resulting from the redesign are indicated. *Aero Digest*, June 1, 1945, pages 118, 120, 148, 1 illus.

Helicoid Movement for Gage Instruments. Paul G. Weiller. A description is given of an improved type of

gearing for pressure indicating gages, which, it is stated, will make possible less costly flight instruments for light planes. This is a cam and roller movement developed by the Certified Gauge and Instrument Corporation. The advantages of this helicoid movement are explained. *Industrial Aviation*, June, 1945, pages 60, 62, 3 illus.

Landing Gear

Aeroplane Wheels and Brakes. J. Wright. The writer reviews developments in airplane wheels and brakes and discusses factors and problems connected with their design. Consideration is given to the requirements for the modern airplane with its high landing speed, low drag, and retractable undercarriage; the dimensions of the pneumatic-tired wheel; and the arrangement of the wheels. The layout of the tire, wheel, and brake unit is detailed. A digest is given of the discussions offered by several members, as well as the writer's reply to the discussions. *The Journal of The Royal Aeronautical Society*, May, 1945, pages 225–250, 8 illus.

Lubrication

Military Aircraft Grease Lubrication. Major S. C. Britton and W. Schlesinger. In this paper the writers supplement and bring up to date information about military aeronautical greases which was set forth in a previous study. Methods of grease application in service and specification test methods are summarized. Particulars are given regarding the performance of greases in various types of equipment. Other sections of the paper discuss the limitations of present greases, improved laboratory test methods, and the direction in which grease research and development is proceeding. It is shown that the method of application may influence selection of and specifications for greases. Increased emphasis on performance tests in specification writing is noted, and the writing of specifications to satisfy a set of performance requirements rather than to duplicate a known satisfactory material is reported. *SAE Journal*, June, 1945, pages 305–313 (Transactions), 12 illus.

Maintenance

Carrier Aircraft Maintenance Is Really Tough. Blaine Stubblefield. From observations aboard the U.S.S. "Bonhomme Richard" at sea, the writer gives a report of how aircraft maintenance is conducted on a U.S. aircraft carrier. The information related pertains to procedures, equipment, and personnel, as well as to special problems of space, motion, and weather to be overcome in the care and repair of airplanes aboard a ship. Some of the more common accidents peculiar to carrier-based planes are described, while the limitations of Class D maintenance (the classification within which lies aircraft maintenance aboard a carrier) are defined. *Aviation*, June, 1945, pages 106–108, 4 illus.

Renewing Aluminum Oil Cooler. Robert E. Desch. Methods of repairing aluminum oil coolers for Army aircraft are described. It is noted that, compared with copper coolers of the same size, aluminum coolers are lighter, provide greater heat transfer, and make possible greater aircraft maneuverability and faster climb. It is explained that it has not been found practical, so far, to rebuild the aluminum cooler, the construction of which resembles a tubular boiler, because an unusually accurate temperature in the brazing furnace is necessary. Particulars are given regarding the special method developed for repairing leaking tubes. *Aviation Maintenance*, June, 1945, pages 50–53, 15 illus.

Ingenuity of Servicemen Sparks Air Power Maintenance. Seventeen examples are given of aircraft-maintenance improvements which have been originated by Army and Navy service mechanics. Many of the tools and methods mentioned are illustrated. *Aviation*, June, 1945, pages 153–156, 17 illus.

Reducing Engine Maintenance. Walter C. Bauer and David T. Thomas. A description is given of the nature of engine lubricating-oil contaminates and methods of removing them. It is explained that products resulting from oil decomposition, which are invisible, can be removed by filtering through an active adsorbent material such as adsorbent clay. Visible contaminates, such as grit and metal chips, may be removed by various absorptive materials including cellulose. A large part of the article is devoted to a description of tests conducted by the Army Air Forces to determine the advantages and maintenance benefits derived from the clarification and filtration of the oil in aircraft engines. Twenty P-40 fighter aircraft powered with Allison engines were assigned for the tests. Comparative data obtained from the tests are shown. The results of the tests are discussed. *Aviation Maintenance*, June, 1945, pages 74, 75, 100, 102, 106, 108, 110, 4 illus.

Successful Overhaul Business Demands Shop Organization. Part V. E. F. Lindsley. The fifth article in a series examining the various phases of aircraft engine service and overhaul is concerned with the organization of an efficient overhaul business. It offers advice about specific procedures for such organization from both the technical and business standpoints. The various personnel components of an overhaul shop are indicated, together with an outline of the duties of each. Accounting methods and what they should accomplish are discussed. A chart of the business organization of a typical overhaul shop shows the various departments necessary for efficient operation, as well as the relationship between them. *Aviation*, June, 1945, pages 157–159, 271, 2 illus.

Management

Finding Post-War Jobs for Wartime Workers. La Motte T. Cohu. The Chairman of the Board and General Manager of Northrop Aircraft, Inc., tells how the company has set up a job plan for helping its strictly wartime employees with the task of relocating themselves in new jobs. Details are given about the plan, which, it is noted, is a relatively simple scheme for bringing employers and prospective employees together as quickly as possible in the postwar period. *Factory Management and Maintenance*, June, 1945, pages 113, 114, 2 illus.

Outlining the "Stanley Plan." An explanation of the Stanley Plan, a procedure by which factories with subcontracting facilities are informed of available jobs so that they can determine whether they are equipped to do the specific jobs and thus apply to the prime contractor for the work. The basis of the plan is the circulation of a digest containing an index of machine combinations required to do each job, made possible by the use of a three-letter symbol individual to each machine tool. Indicating the advantages of the plan to prime contractors, subcontractors, and the Government, the article tells how it will be applied for peacetime reconversion work. *Aero Digest*, June 1, 1945, pages 58, 242, 1 illus.

Marketing

Aircraft Sales Control. J. A. Grundy. The advantages of an effective sales-control record in the marketing of products are enumerated. It is stated that the aircraft dealers who will grow and prosper will be those who know how to use organized facts for control purposes. A description is given of the prospect-control record used by Parks Aircraft Sales & Service of East St. Louis. *Aviation Maintenance*, June, 1945, pages 48, 49, 122, 124, 128, 1 illus.

Materials

Steel as a Material. E. P. Strothman. Consideration is given to the advantages of steel over lighter metals for certain aircraft parts in which it is desirable to keep the weight low. Several examples are given of aircraft parts that were found to be not only stronger and more easily fabricated when made of steel, but also a little lighter. These include a B-29 bomber nose frame and some airplane landing-gear members. It is explained that the findings do not indicate that steel should replace lighter metals in every case but that when a part is being designed all possible materials should be considered. It is emphasized that particular consideration should be given to the ratio of strength to weight and the modulus of elasticity of each material. *SAE Journal*, June, 1945, pages 314–320, 344 (Transactions), 14 illus.

Beryllium Copper. L. Sanderson. The properties of beryllium copper are described, its usefulness in the manufacture of springs is indicated, and methods of treating the materials are surveyed. Suggestions are given as to the correct

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procedures to follow in heat-treating, quenching, and work-hardening beryllium-copper alloys. Springs made of this material are claimed to be highly resistant to shock, wear, fatigue, and corrosion. *Aircraft Production*, June, 1945, pages 287, 288.

Limitations of Dielectric Heating. Carl J. Madsen. This paper is concerned only with that phase of high-frequency heating which deals with the treatment of materials by a varying electric field, and reviews the major limitations that prevent its universal application. The writer deals with the subject under headings of cost, frequency, voltage, and loss factor, giving the conditions under which the process is economically attractive. One formula is derived for calculating the heating of dielectric materials and one for determining the maximum frequency that can be used. *Aero Digest*, June 1, 1945, pages 112, 240.

Photograph Courtesy A. O. Smith Corporation

Separate press form pieces for a B-29 bomber steel nose frame. In this particular application steel was found to be more desirable than lighter metals.

Medicine

Night Blindness in Flying Personnel. William M. Rowland and Louise L. Sloan. This is a report on a study conducted at the Army Air Forces School of Aviation Medicine, in which pilots who had experienced difficulties in night operations, were tested. In these tests use was made of the A.A.F. Eastman Night Vision Tester, Hecht-Shlaer Adaptometer, SAM Portable Night Vision Tester, and Sloan Perimetric Light Sense Tester. The four methods of testing are described, and the results of the tests are analyzed. Consideration is given to the effects of vitamin therapy on night vision. *The Journal of Aviation Medicine*, April, 1945, pages 48–58, 13 illus.

The Effect of Hyoscine on Airsickness. Lt. Joseph L. Lilienthal, Jr. This article reports observations on the effect of hyoscine as a preventive of motion sickness occurring in aircraft. The effect of the drug was studied in a large unselected test group of Naval Aviation cadets and in a small group of individual subjects complaining of chronic airsickness. The methods used in this survey are described and the results are discussed. It is concluded that hyoscine hydrobromide in doses of 0.6 mgm. administered perorally 30 to 60 min. before flight is a potent preventive of airsickness with insignificant side effects. Controlled experiments with a lactose placebo indicated that this protection is not attributable to the psychologic effects of a nonspecific medication. *The Journal of Aviation Medicine*, April, 1945, pages 59–67, 1 illus.

Aviation Nutrition Studies. C. G. King, Hylan A. Bickerman, Winifred Bouvet, C. J. Harrer, James R. Oyler, and C. P. Seitz. An investigation was undertaken to explore certain possible practical dietary measures that might increase (or decrease) resistance to functional impairment resulting from exposure to altitude. The effects of preflight and inflight meals with respect to carbohydrates, proteins, and fats were studied. Primary emphasis was placed on quantitative records of functional performance and food intake together with standardization of test subjects. Repeated tests during 18 months of well-controlled experimental study, including the use of 25 different research subjects and two independent groups of observers, indicated that significant gains in altitude tolerance can be accomplished by ingesting preflight and inflight foods of relatively high carbohydrate content. *The Journal of Aviation Medicine*, April, 1945, pages 69–84, 11 illus.

The Application to Commercial Aviation of Some Physiological Factors Developed by Military Aviation Medicine. L. G. Lederer. In this paper the writer notes that the prosecution of the war has stimulated the necessity for advances in the field of aviation medicine and produced many techniques that can be used for the purpose of promoting human comfort in the postwar period of commercial aviation. He then attempts to show how the programs of night vision, pressurized cabins, pilot fatigue and nutrition, low-pressure chamber indoctrination, mental preselection, and air evacuation studies can be applied to postwar commercial aviation. *The Journal of Aviation Medicine*, April, 1945, pages 85–90.

Spontaneous Subarachnoid Hemorrhage Occurring in a Pilot During Flight. Major Jack O. W. Rash and Capt. Frank M. Goldys. The first reported case in American medical publications of spontaneous subarachnoid hemorrhage occurring in a fighter pilot during flight, with survival, is described. The etiology and pathology of this condition are briefly mentioned. Events that may have acted as precipitating factors in this particular case and their possible manner of operating are discussed. *The Journal of Aviation Medicine*, April, 1945, pages 91–95.

Episcleritis in a Flying Officer. Capt. Lambert J. Agin. To show the prognostic importance of a differential diagnosis between catarrhal conjunctivitis and episcleritis of the benign, nodular type, the case history of a flying officer is presented and discussed. *The Journal of Aviation Medicine*, April, 1945, pages 96–98.

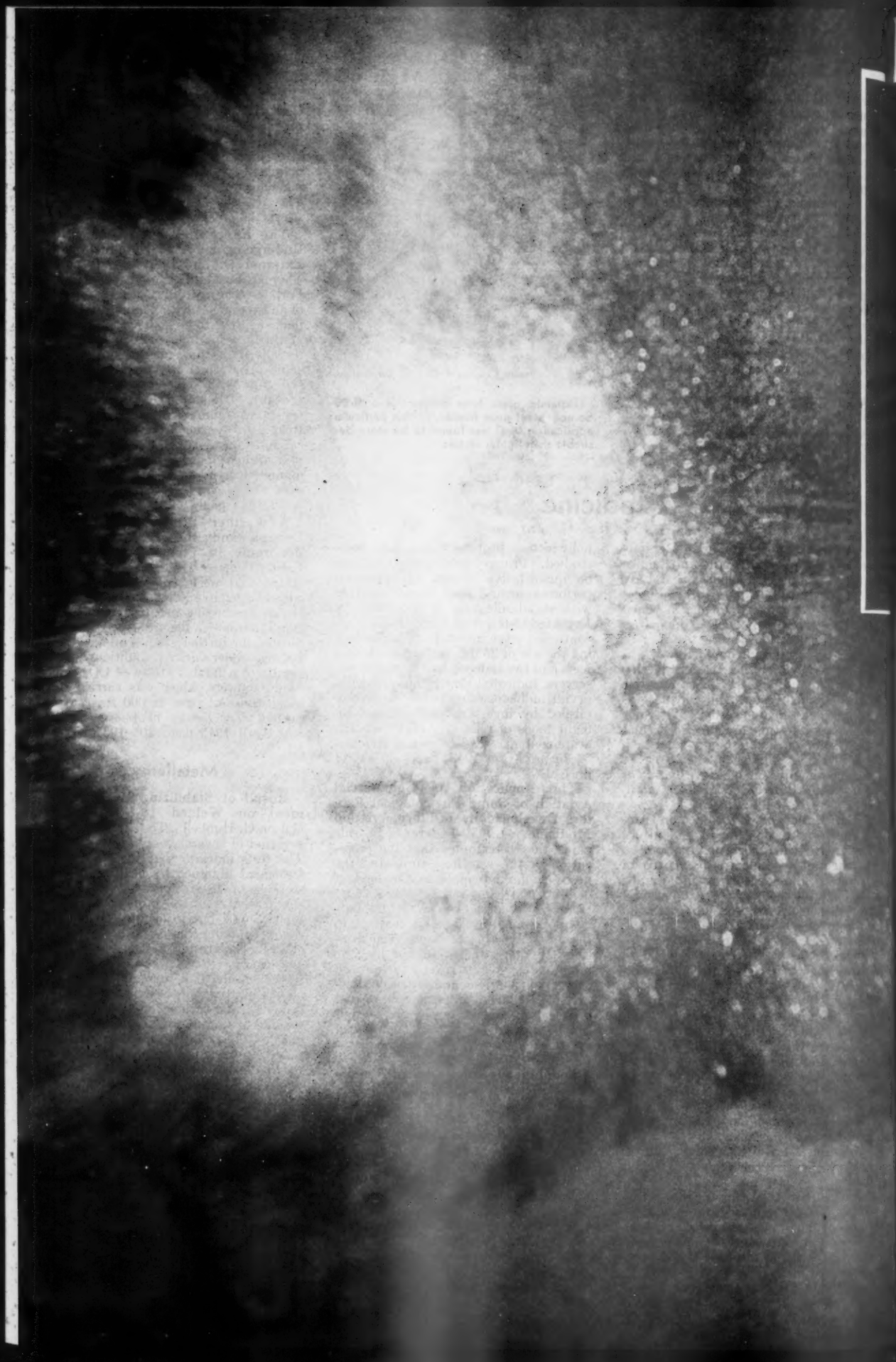
The Effect of Thiourea on Mice Undergoing an Abrupt Reduction of External Atmospheric Pressure. Thomas S. Gardner and Francis B. Forbes. The writers report the results of an experiment with white mice which indicates that there is danger in the use of thiourea for high-altitude flight, especially if the subjects are in a sealed-cabin plane which may be broken open suddenly with a consequent drop in pressure. It is stated that the decreased resistance to anoxia in the thiourea-treated mice parallels the lessened physical resistance. It is possible that thyroid stimulators would act in a contrary manner for sudden reductions in pressure. *The Journal of Aviation Medicine*, April, 1945, pages 99, 100.

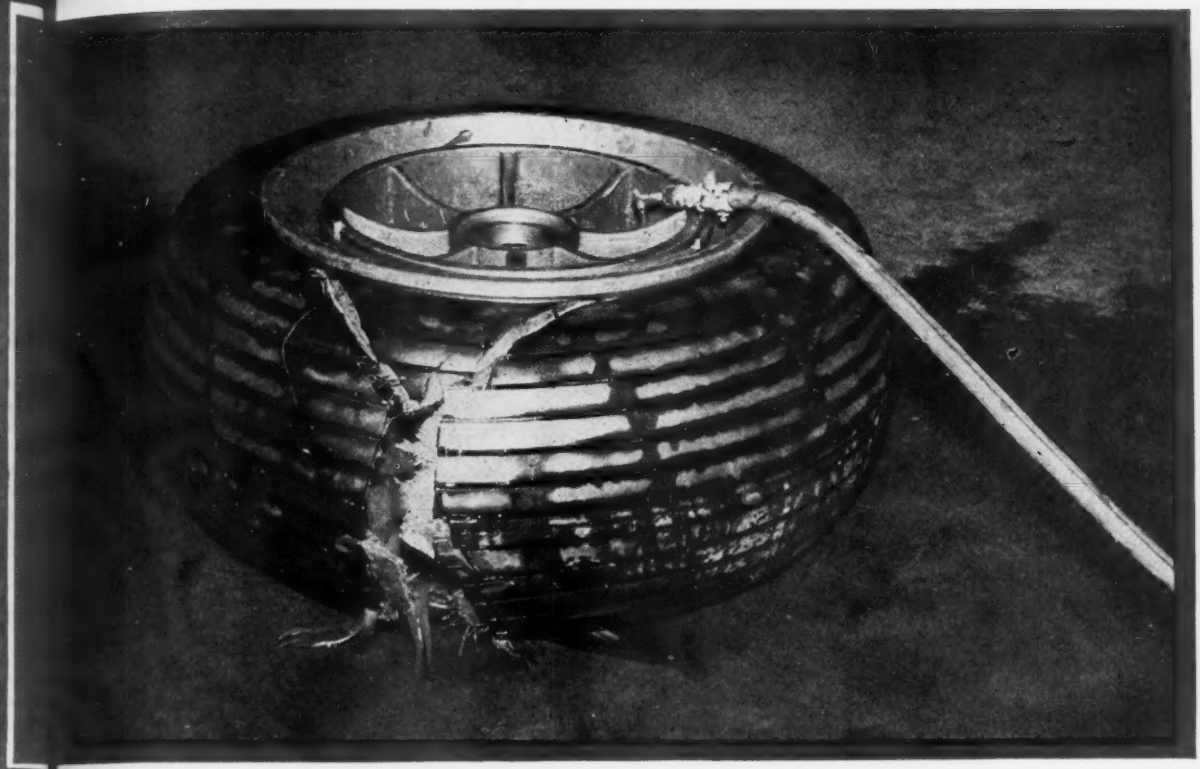
A Further Study on Muscular Cramps and the Hyperventilation Syndrome in Flyers in the ETO. Capt. Wallace G. Beckman. It is stated that while considerable knowledge is available about the mechanical changes occurring in the hyperventilation syndrome in fliers, the need was indicated for further studies on acid-base balance under various conditions. The results of a further study of CO_2 combining powers, which was carried out at altitudes of over 20,000 ft., are reported. *The Journal of Aviation Medicine*, April, 1945, pages 101–103.

Metallurgy

Result of Stabilizing Heat Treatment on Welded 18-8 Stainless. Wilson G. Hubbell. Tests made during a period of several years are reviewed. The tests indicate that the stabilizing treatment obtained by heating welded sections of 18-8, Types 321 and 347 stainless steel for 30 min. at 1,650°F. exerts small, but inclusively beneficial, results in aiding the metal to resist the effects of corrosive aqueous solutions and electrolytes. The writer reaches the conclusion that there appears to be no justification for assuming that this type of heat-treatment increases the resistance of aircraft-engine exhaust manifolds to intergranular attack by exhaust gases at elevated temperatures. He states that this conclusion has special significance when it is realized that aircraft exhaust manifolds encounter no environment in service as corrosive as copper sulphate sulfuric acid solution. In addition to the metallurgic considerations, there are some manufacturing problems that would add to the cost of the finished product. *The Iron Age*, June 21, 1945, pages 56–60, 13 illus.

Effect of Boron on Aluminum Castings. A brief article describes tests to determine the effects of boron trichloride on aluminum permanent-mold casting alloy at Northrop Aircraft, Inc.





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It was determined that this modifier, used in Alloy 356, which contains 7 per cent silicon and 0.3 per cent magnesium, serves to refine the grain structure and modify the microporosity from the sharp shrink type to the rounded gas type of cavity. It was also determined that the process reduces the mechanical properties of the castings and increases the brittleness but does not affect corrosion resistance or heat-treatment characteristics of the alloy. The test specimens are described, with their chemical analyses. *The Iron Age*, June 21, 1945, page 61, 2 illus.

Meteorology

Saturation and Cooling of Air Layers by Evaporation from Falling Rain. Lt. Edward J. Dolezel. The changes in temperature and relative humidity caused by evaporation from raindrops are computed for several cases involving three different lapse rates and two rainfall intensities. Formulas for evaporation from stationary drops are modified to include the effects of relative velocity and continuously changing air temperature. It is found that saturation, attributed to evaporation alone, will not be produced in an isothermal layer or a layer having a decrease of temperature with height. In the case of the isothermal layer, the air is close to saturation after 6 hours. The temperature decrease during the same interval is 4.5°C. Because of the lower equilibrium drop temperature, the final relative humidity in a layer having a moist-adiabatic lapse rate is near 97 per cent and the temperature fall is slightly smaller. In an inversion, however, the humidity reaches 100 per cent in $2^1/_2$ hours and approaches 107 per cent after 6 hours. The excess moisture present is sufficient to produce fog or clouds. In general, evaporation is greatest in the warmest part of a layer; the change in relative humidity is greatest in the coolest part. Thus, the ceiling would build down from above in a layer having a normal lapse rate provided other influences tending to produce condensation are present. Inversions favor the formation of fog or low stratus because of evaporation alone. *Journal of Meteorology*, December, 1944, pages 89–97, 8 illus.

Upslope Weather Along the Inland Alaska Air Route. Major Louis L. Kolb and Lt. Murel M. Goodmanson. The writers discuss upslope circulation and its accompanying weather phenomena along the portion of the inland Alaska air route that lies east of the Rocky Mountains, which is stated to be a major factor influencing aircraft operation. Great Falls, Mont., is given the greatest consideration since it is taken as representative of stations on the east slopes of the Rocky Mountains, and more data are available for this station. The air masses involved in the occurrence of upslope circulation and associated phenomena are ascertained. Upslope weather types are classified into pure upslope, upslope-overrunning, upslope-radiation, and overrunning predominant with upslope as a minor factor. These types are correlated with typical synoptic examples. Forecasting of the formation and cessation of upslope weather phenomena is discussed on the basis of lower-air trajectories and the use of typical examples. Concrete deductions resulting from a study of many synoptic situations are enumerated as an aid in forecasting the formation and cessation of these phenomena. *Journal of Meteorology*, December, 1944, pages 98–108, 21 illus.

World Weather. Some notes on the organization and operations of the meteorology division of the Royal Air Force's Transport Command. The weather-forecasting services performed for the Command's pilots by this division and the manner in which they are carried out are surveyed. *Flight*, May 31, 1945, pages 582b, 583.

Some Properties of the Ten Thousand Foot Low Center. Frank L. Martin. Reference is made to the meteorologic precept that the trough aloft "leans toward the colder air" and the high-pressure center or wedge aloft "leans toward the warmer air." It is noted that both these statements are based on the hydrostatic equation. The writer presents a method for locating the upper troughs or centers at the 10,000-ft. level more exactly as a function of the sea-level centers and the mean virtual isotherm distribution. *Journal of Aeronautical Meteorology*, April, 1945, pages 83–91, 3 illus.

The Causes and Forecasting of Low Ceilings and Visibilities at Cleveland Municipal Airport. Frank M. Van Sickle. Following an outline of the general conditions affecting the weather at the Cleveland Municipal Airport, the writer presents a statistical treatment of the subject. The times during which the ceiling was 600 ft. or less, or the visibility was 1 mile or less, during the 4 years from 1940 to 1943, are recorded and divided into seven classifications. Cases of subminimum weather caused by thunderstorms are not included. The seven classifications studied include radiation fog; advection-radiation fog; prewarm front fog; postcold front fog; prewarm plus postcold front fog; lake snow showers; smoke pollution. *Journal of Aeronautical Meteorology*, April, 1945, pages 92–108, 20 illus.

Method of Selecting Favorable Winds by Use of Thermal Vectors. E. S. Pulk. It is noted that with the advent of long-range transoceanic airline operations, the most efficient use of available meteorologic information will be imperative in order to decrease operational expense. An outline is given of basic rules for determining winds at altitudes different from the altitude at which the flight is being made. These rules enable a pilot during flight to find more favorable winds and thus to decrease the flight time. It is explained that the theory for these changes of winds with elevation is based on thermal winds, and that the results are accurate as long as the gradient of the mean temperature of the air columns surrounding the aircraft is known. Methods for estimating this mean temperature are described. *Journal of Aeronautical Meteorology*, April, 1945, pages 109–119, 17 illus.

The Occurrence of Hail in Thunderstorms. C. E. Buell. Some theories on the formation of hail are briefly discussed. Measures of thunderstorm intensity are reviewed. The consideration of the ratio of the occurrence of thunderstorms to that of hail as a measure of general thunderstorm intensity is proposed. On this basis the geographic distribution of thunderstorm intensity over the United States is considered together with the annual variation of thunderstorm intensity at several points. It is concluded that nearly all thunderstorms during spring, fall, and winter in the central United States produce hail at some period during their life cycle. *Journal of Aeronautical Meteorology*, April, 1945, pages 120–128, 17 illus.

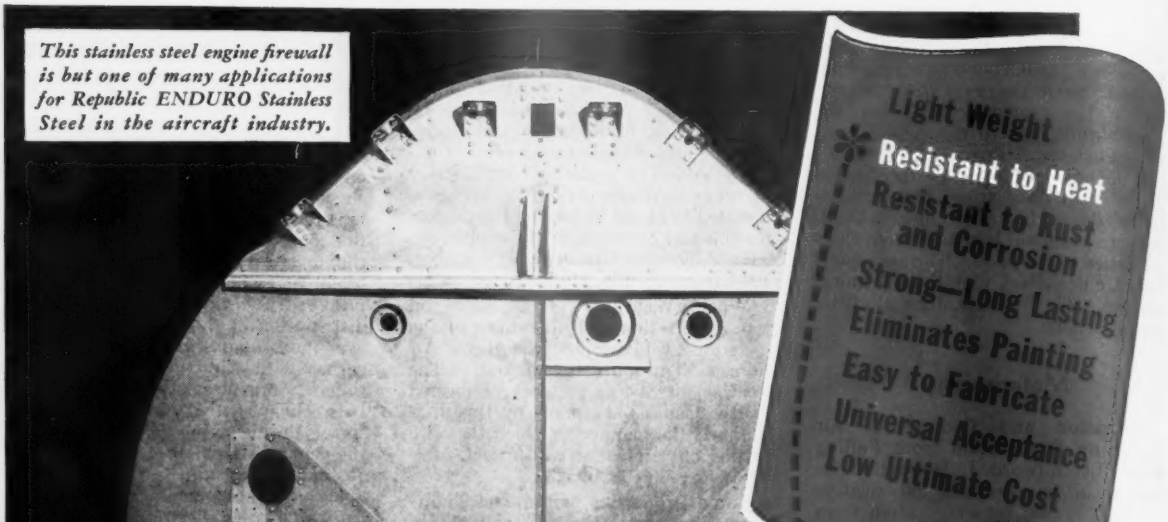
Military Aviation

Combat Cargo Task Force. Squadron Leader Charles Gardner. First of a series of articles on various aspects of the Burma campaign, this one tells how the British 14th Army fighting in Burma was supplied and sustained for a whole year exclusively by air. Methods by which 2,200 tons and 1,600 troops were transported daily are described. An explanation is also given of why this air supply system was necessary and why, without it, the 14th Army would have been stymied in Burma. *Flight*, May 24, 1945, pages 553–556, 6 illus.

Combat Cargo Task Force. Squadron Leader Charles Gardner. Continuing an account of the role played by air power in various phases of the Burma campaign, this second article in a series covers the period when the British 14th Army moved over the Chindwin and started its central Burma offensive. It is related how the operation of Troop Carrier Command planes from 200 landing strips which were constructed for the purpose sustained this phase of the campaign; supplying troops and transporting them, bringing in supplies for civilians as well as soldiers, and for construction as well as maintenance. The work of combat aircraft in safeguarding the air supply system is noted. *Flight*, May 31, 1945, pages 588–590, 4 illus.

Fighter Escort Tactics. James L. H. Peck. An analysis of how American fighter groups operate when providing cover for bombers to and from a target. The evolution of fighter tactics, techniques, and equipment since the beginning of the war is outlined. *Flying Age*, July, 1945, pages 11–13, 53–56, 3 illus.

Free Airmen of Europe in the R.A.F. Henry Baerlein. This article is divided into several sections, each recounting the work of air groups from a different allied country which fought as units of the Royal Air Force. Highlights are reported from the air-combat records and achievements of French,



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Dutch, Belgian, Polish, Czechoslovak, Norwegian, Greek, and Yugoslav airmen. *The Aeroplane*, May 18, 1945, pages 579–581.

Air Policemen. S. Ralph Cohen. This article is about the Occupational Air Force. The writer describes how the U.S. Army Air Forces are building another air organization as their first experiment in a new application of air power. It is noted that the Occupational Air Force will work in conjunction with the ground forces to maintain peace. The specifications for the O.A.F., which are being worked out by the Air Forces' leaders, are discussed. *National Aeronautics*, June, 1945, pages 15, 16, 2 illus.

Air War Inside Germany. Roger Montgomery. This is an eyewitness description of the closing stages of the air war within Germany. The lavishly equipped airfields, the jet aircraft, and the background of German air power on which the enemy had relied for victory are described and illustrated. *Aeronautics*, June, 1945, pages 32–41, 26 illus.

The Bombsight. A detailed explanation of how the Norden bombsight operates. Describing the bombsight as consisting basically of two mechanisms, the article investigates the functioning principles of their various components. The two main units are defined as (1) a lower unit or stabilizer for keeping the line-of-sight direction fixed or controlled; and (2) an upper unit, consisting of a number of assemblies, most important of which are the telescope, the computer, and the gyro. Several photographs illustrate the explanation. *Flying*, July, 1945, pages 28–30, 124, 126, 6 illus.

Naval Aviation

Tigercat Unveiled by Navy as Most Powerful Fighter. A brief description is given of the performance characteristics of the Grumman F7F Tigercat, the Navy's first twin-engined fighter and fighter-bomber. It is reported to have superior speed, climb, and power, and to be faster at sea level than any Japanese craft. Its speed at critical altitude is rated in the 425 m.p.h. class, it can carry 4,000 lbs. of bombs or a full-sized marine torpedo, or rockets, and its range can be extended by the use of a 300-gal. drop tank. The craft is powered by two 2,100-hp. Pratt & Whitney Double Wasp engines and is equipped with folding wings and tricycle landing gear for operation from carriers of the 45,000-ton "Midway" class. In addition to the regular version, a night-fighter version of the Tigercat is a two-place model designated as the F7F-2N. *Aviation News*, June 11, 1945, page 11.

Riding the Gas Bag Control. Thomas E. Stimson, Jr. How lighter-than-air craft are being used to rescue survivors of marine disasters is described. Particulars are given about rescue gear perfected by the Airship Experimental Command, which makes an airship self-sufficient for handling practically any type of marine rescue in any weather. The method of using a ring with a webbed seat, called an "elevator," for raising survivors from the water to the cabin of a Navy blimp is described. *Popular Mechanics*, July, 1945, pages 65–69, 14 illus.

Paints and Coatings

Metallizing in Airline Shops? Joseph H. Riseley. Information is supplied about the metallizing process which, it is stated, has not been used extensively in air-line shops but has proved itself in railroad, bus, and truck shops. The use of metallizing as a coating process and as a putting-on tool for building up worn cylindric parts and repairing defective castings is discussed. The technique of metallizing parts is outlined. How the metallizing process has aided the aviation industry is described. Air-line applications where metallizing has proved effective are mentioned. *Air Transport*, June, 1945, pages 46, 49, 50, 5 illus.

Plastic Coatings Protect Carbide Tipped Tools. Bernard Gould. This article describes the use of plastic dip coatings as a means of cushioning tools and machined parts from chipping and abrasion while in the storage crib or in transport. The writer tells about the economies realized with these coatings and the method of applying them. *The Iron Age*, June 14, 1945, pages 66, 67, 5 illus.

Personalities

Soviet Designers and Their Planes. Major G. Zalutsky. Brief personal histories are given of five outstanding aircraft designers of the Soviet Union. Some information is also given about the planes they have designed. It is noted that Soviet aircraft designers have not only modified and improved existing models but have also created new types of aircraft. The activities of the following designers are outlined: Semyon Lavochkin, Alexander Yakovlev, Serge Ilyushin, Andrei N. Tupolev, and Vladimir Petlyakov. *Model Airplane News*, July, 1945, pages 14, 15, 40, 10 illus.

Forgotten Pioneer. Wayne Foster. This biographic article on Ed B. Heath traces his participation in aviation developments from 1908 to 1931. It features the man's accomplishments as designer of the Heath Parasol and other aircraft, and as pioneer pilot and early manufacturer of efficient, low-priced light planes. *Flying*, July, 1945, pages 56, 57, 92, 94, 96, 4 illus.

Fighting Freddie of the Flying Cavalry. Sidney Shalett. A biographic record and character study of Brig. Gen. Frederic Harrison Smith, Jr., of the Army Air Forces. The article not only traces General Smith's early history, his career in the Army, and his achievements during World War II, but also explains briefly the principles of tactical air power which are advocated and followed by him. *The Saturday Evening Post*, July 7, 1945, pages 20, 89, 90, 1 illus.

Personnel

Personnel Records. Raymond C. Halliday. The writer discusses methods of keeping records concerning employees. It is noted that these records range from the essential facts necessary to make a payroll record to elaborate systems covering all phases of employee history. A description is given of the way that Bell Aircraft Corporation revised its program when an urgent need arose for a method that would permit the rapid accumulation of complex data covering 30,000 employees. *Industrial Aviation*, June, 1945, pages 32, 33, 2 illus.

Plastics and Plywood

New Plastic Laminate for Aircraft Parts. This article describes a new low-pressure plastic laminate named Conolon, which is being used at the Consolidated Vultee Aircraft Corporation in the fabrication of certain airplane parts. It is explained that Conolon is made in three types, each of which consists of a fiber impregnated with a thermosetting resin. Particulars are given about the manufacture of each type. The procedure followed in laminating Conolon moldings is described. Precautions that must be observed in order to obtain good laminates are listed. It is stated that, because the material has great resistance to vibration, it is particularly desirable for airplane parts. The physical properties of this plastic laminate are listed. Information is given regarding the results of test of a trailing-edge overflap of a B-24 wing that was molded from Conolon. *Automotive and Aviation Industries*, June 1, 1945, pages 37, 67, 2 illus.

Reflective Signs and Markers. Allen Wagner. This article tells how minute glass beads are applied to a resin film to form a reflective material used as markers for airport runways and other purposes. Paper was formerly used as the backing for the glass beads, which were attached with rubber cement, but resins are now used for the entire job. *Modern Plastics*, June, 1945, pages 120, 121, 3 illus.

Phenolic Fibre in Airplane Parts. Gerald Eldridge Stedman. The writer discusses the characteristics, design features, and fabricating behavior of the phenolic fibers as exemplified in their application in several B-25 bomber parts. Forming operations are described and illustrated. *Metals and Alloys*, June, 1945, pages 1658–1662, 8 illus.

Postwar Aviation

Wings for Peace. K. R. Jackman. Quoting from predictions made by various aviation leaders, this is a survey of prospective developments that are expected in air transport after the war. The prognostications touch upon types of equipment, fares, speeds and ranges, and the extended utilization of rocket propulsion. The authorities quoted

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include W. W. Davies, United Air Lines Research Engineer; A. N. Kemp, President of American Airlines; Ralph S. Damon, Vice-President and General Manager of American Airlines; Jack Frye, President of Transcontinental & Western Air, Inc.; Sir Roy Fedden, Special Technical Adviser to the British Ministry of Aircraft Production; G. E. Pendray, Secretary of the American Rocket Society; and Professor A. M. Low. *Canadian Aviation*, June, 1945, pages 76–79, 110, 5 illus.

Swiss Planning. E. A. Bell. An account is given of Switzerland's contemplated scheme for the expansion of landing facilities to help promote air commerce after the war. The plan calls for four main urban airports at Basle, Geneva, Zurich, and Berne—with the Zurich airport to be a central one for international air traffic—and five minor "regional airports." Some of the measures that have been taken and others that will be necessary to carry out the contemplated plans are noted. *Flight*, May 10, 1945, page 501.

Private Flying

Cross Country Notes. Leighton Collins. These notes contain a number of the writer's observations made during a light-plane airplane trip from New York to Texas and back. Among the subjects they refer to are the prospective plans of Lycoming Division of The Aviation Corporation, Piper Aircraft Corporation, Globe Aircraft Corporation, Stinson Division of Consolidated Vultee Aircraft Corporation, Bellanca Aircraft Corporation; the Fairchild Packet; two new propellers—the Koppers Aeromatic propeller and the Sensenich two-position propeller; progress on the Bell helicopter; operations of Piedmont Aviation; and the Johnson Rocket. Included in the writer's suggestions for the improvement of private flying is the recommendation that descriptive area-weather broadcasts be set up to assist the contact pilot flying cross-country. *Air Facts*, July, 1945, pages 66–80, 82–85, 5 illus.

Challenge for Safety to Private Flying. John H. Geisse. Some comments on the greater degree of responsibility for prevention of flying accidents which falls upon various classes of people with the revisions of Civil Air Regulations that went into effect July 1, 1945. With regard to this point, responsibilities of the pilots and owners of personal aircraft, the manufacturers, the rated instructors, and the airport operators are discussed. *Southern Flight*, June, 1945, pages 32, 40.

Buying a Plane? William D. Strohmeier. Further advice for prospective buyers of airplanes is given in this fourth of a series of articles. The writer discusses features of the airplane which should be investigated. These include visibility, the seating arrangement, passenger and baggage capacity, the width of the doors, and the comfort afforded by the seats. Financing plans also are considered. *National Aeronautics*, June, 1945, pages 17, 24, 25, 1 illus.

Production

Final Operations. G. Schlesinger. This is the first half of a two-part article dealing with the surface finish in final machining operations. In addition to reviewing the requirements and problems of obtaining good surface finish, it comprehensively surveys finishing processes, equipment for producing the surfaces, and instruments for measuring roughnesses. Processes are classified in two categories, chip-removing processes and chipless processes, with the former subdivided into operations using (a) single-point tools, (b) multiple-point tools with regularly arranged cutting edges, and (c) abrasive tools. Charts, tables, and photographic illustrations amplify the data offered in the article. *Aircraft Production*, June, 1945, pages 266–273, 22 illus.

Setup Charts for Automatic Screw Machines. John J. Meadows. A series of four articles describes graphic methods that make it possible to solve problems involving speeds and feeds in automatic screw machines in a fraction of the time required to make the calculations from handbooks. In the first article eleven charts are presented for various sizes of Acme-Gridley screw machines. The second article contains six charts for the graphic solution of problems involving speeds and feeds, tapping, and high-speed drilling change-gear ratios for Conomatic $2^5/_8$-in. screw machines. In the third article, speed and feed change-gear charts, as well as high-speed drilling and tapping gear ratios, are supplied for $1^5/_8$-in. six-spindle New Britain-Gridley screw machines.

The fourth and concluding article contains charts for the graphic solution of problems involving speeds and feeds on Davenport and Brown & Sharpe automatic screw machines. *The Iron Age*, June 14, 1945, pages 54–60, 11 illus.; June 21, 1945, pages 62–66, 6 illus.; June 28, 1945, pages 67–72, 10 illus.; July 5, 1945, pages 63–71, 8 illus.

Impact Extruded Aluminum Parts: Their Design and Production. Marcus A. Fair. Possibilities offered by the impact-extrusion process in the design and application of aluminum parts are discussed. It is noted that impact extrusions may be described as cup-shaped parts having cold-forged bottoms combined with extruded side walls, and that they are made in one operation from cold slugs. To indicate when and how designers can use extrusions, particulars are given about features of design that can be produced and the scope and limitations of the extrusion process. *Product Engineering*, June, 1945, pages 402–406, 5 illus.

Car Production Principles as Applied to Aircraft. B. G. L. Jackman. This is another article of a series dealing with the utilization of the facilities of automobile manufacturers for the production of aircraft components. Tooling principles are discussed. Information is given about the design of detail tools and simple assembly fixtures. *Sheet Metal Industries*, June, 1945, pages 1021–1030, 1036, 16 illus.

The Production Side of Jack & Heintz. Joseph Geschelin. How the application of human-relationship principles in management has contributed to the success of the Jack & Heintz organization is described. The technical and psychologic methods by which the Jack & Heintz, Inc., plants in the Cleveland area produce starters and generators, automatic pilots, flight instruments, servo units, and energizers for aircraft are explained. Information is also given about the plant layout, production operations, and manufacturing equipment. *Automotive and Aviation Industries*, June 1, 1945, pages 22–25, 82, 85, 10 illus.

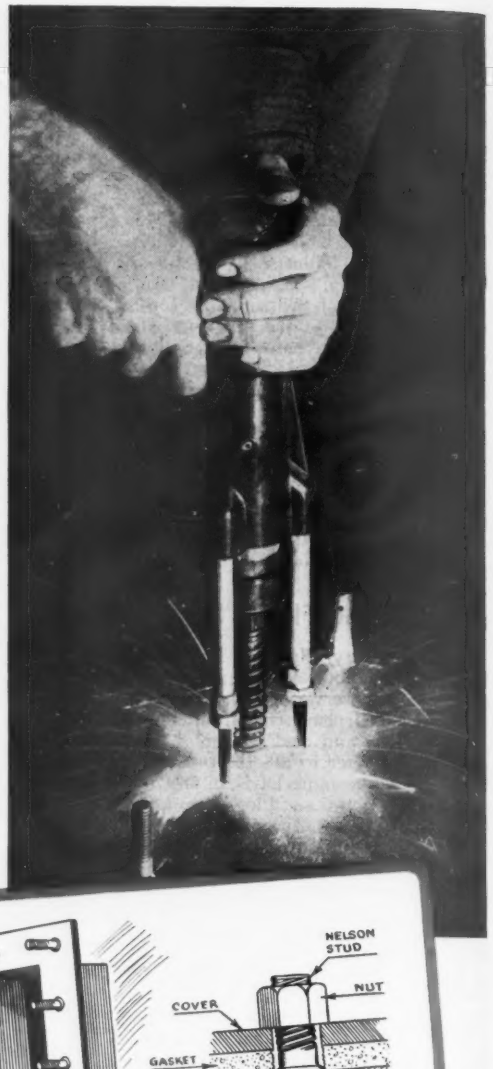
Jet Quench Minimizes Aluminum Distortion. A description is given of new high-speed heat-treating equipment used at the St. Louis plant of Curtiss-Wright Corporation in the production of aluminum-alloy parts for the C-48 Commando. The apparatus is described briefly, as well as the methods of operation. *The Iron Age*, July 5, 1945, page 78, 2 illus.

Selection of Cutting Fluids. James R. Chambers. The characteristics and purposes served by coolants, cutting oils, and grinding fluids used in industry are outlined. The fluids most suitable for different materials are discussed in sections devoted to cutting lubricants for steel and cast iron, cutting compounds for brass, coolants for machining aluminum alloys, and cutting fluids for magnesium alloys. *Machinery*, June, 1945, pages 154–156.

Essential Formulas for a Simple Production Illustration Method. P. R. Hardesty. Together with an outline of derivations, basic formulas are presented for a type of drawing utilized in production illustration. Applied largely to phantom and exploded views, this technique has for one of its main purposes the simple presentation of complicated production assemblies. It is essentially a projection from infinity of an arbitrarily rotated object, on a picture plane at right angles to the projecting rays. In certain instances it is further simplified by using photographic methods to copy the ordinary orthographic working drawings from the correct angle, these copies then being assembled along the proper lines to make the finished projection. *Aero Digest*, June 1, 1945, pages 131, 132, 146, 1 illus.

Sheet Forming Methods; Their Effect on Part Design. Mark P. Meinel. The writer discusses the possibilities and limitations of twelve general methods of forming sheet-aluminum aircraft parts. Factors affecting the selection of a suitable forming method for a specific design are also discussed. *Product Engineering*, June, 1945, pages 374–377, 10 illus.

How Nelson *Automatic* Stud Welding saves time and material—



Here is a complete fusion weld that is obtained in less than ½ second! Yet the resulting stud weld is stronger than the strength of the stud. By this welding method precision work is obtained economically and close tolerances are held.

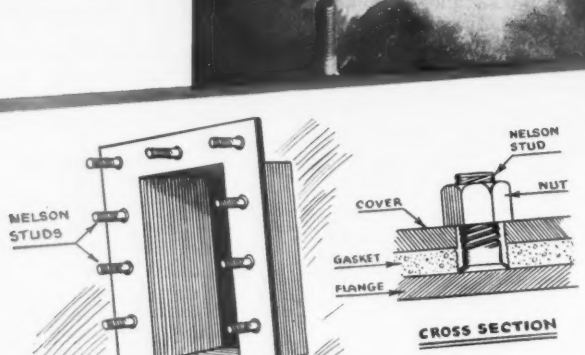
Below is a typical example of how Nelson Stud Welding is helping one manufacturer save time and material. Consistent results like this, *automatically* produced, can be obtained wherever studs can be end-welded to metal surfaces.

The equipment for Nelson Stud Welding is handy to use and completely portable — or may be obtained as a single or multi-gun precision jig for close tolerance production of stud welded parts. It is easily operated by men or women, and no previous welding experience is necessary. Workers are securing 1000 or more studs in eight hours without difficulty.

HOW TO DO IT—

Problem:

SECURING STUDS TO HOLD INTAKE VENT COVERS ON INDUSTRIAL FURNACE.



Former Method--Drill hole through flange, tap hole, insert bolt, and hand-weld head of bolt. Process took too long.

Present Method--Saves more than 40% of the time of former method. Studs are quickly secured with equal strength and accuracy.

After layout and center-punching the studs are welded to the flange. Gasket and sheet metal cover are then installed on top and secured with nuts.

Portable Nelson "gun" well liked because stud welding can be done on furnace while assembling.

Do you have a problem like this stud welding can solve?

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EASTERN REPRESENTATIVE: Camden Stud Welding Corp., 1416 South Sixth Street, Camden, New Jersey

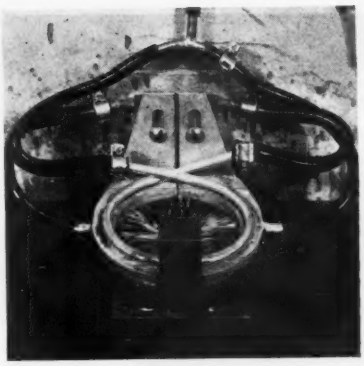
Deviation Stickers Quicken Template Changes. An outline of the process by which the Boeing Aircraft Company facilitates the transmission of design-change information to its subcontractors. Saving time, critical materials, and shipping space, this method is based upon the use of photographically reproduced true-scale shim stock patches, which are superimposed upon the master drawings held by each subcontractor. The various steps in the procedure of processing the deviation stickers onto the original drawings are reviewed. *Aviation*, June, 1945, pages 147, 148, 5 illus.

Electronic Control. The application of electronic control to two sheet-metal joining processes is surveyed. One process is electric-resistance welding, the other riveting. The advantages and operation of automatic control in the case of resistance welding are demonstrated by particulars about special equipment developed for the purpose by The British Thomson Houston Company, Ltd. In the case of riveting, the merits and functioning principles of electronic control are exemplified by a report of the sequence-control unit developed by the Consolidated Vultee Aircraft Corporation for the purpose of increasing the efficiency of Erco riveters. *Aircraft Production*, June, 1945, pages 261–265, 8 illus.

Making High-Quality Magnesium Castings. A. Vernon Lorch. It is stated that, in melting magnesium sand-casting alloys, experience shows that a number of foundry variables must be controlled very closely in order to minimize the occurrence of undesirable chemical and physical properties in the castings. A detailed account is given of some procedures that have proved successful in preventing undesirable chemical and physical properties from being obtained when melting and pouring magnesium sand-casting alloys. *Metals and Alloys*, June, 1945, pages 1652–1657, 7 illus.

Fabricating the P-47 Wing. Gerald E. Stedman. This is a description of manufacturing methods that have enabled Servel, Incorporated, of Evansville, Ind., to increase greatly the production of wings for the P-47 and to reduce production costs. Production operations and techniques are described and illustrated. *Industrial Aviation*, June, 1945, pages 69–71, 102, 103, 7 illus.

Efficiency of "Helldiver" Production. A survey of production methods utilized by the Columbus, Ohio, plant of Curtiss-Wright for the manufacture of the SB2C-4 Helldiver. Innovations in both procedures and equipment are noted. Among described factors credited with the speeding of production are (1) more detailed breakdown of major subassemblies, enabling larger groups of employees to work simultaneously on a greater number of fixtures; (2) a system of closer control over the flow of parts and assemblies; (3) changes in shop practices; (4) the installation of



A combination induction coil and quenching fixture used for case-hardening Curtiss Helldiver tail wheel cams. The cam is not shown so that the spray that quenches and hardens it can be seen.

mechanical equipment wherever possible. *Aero Digest*, June 1, 1945, pages 114, 116, 148, 4 illus.

Induction Heating Speeds Helldiver Production. E. K. Fry. Particulars are given about the induction-heating technique employed by the Curtiss-Wright Corporation Columbus plant for the fabrication of Curtiss Helldivers. The processing method reviewed is reported to have been adapted for numerous brazing, production, and salvage procedures. It features the use of an induction-heating machine with a four-outlet table for different coils, and the cooling of inductor coils by distilled water. *Aviation*, June, 1945, pages 138–140, 6 illus.

Propellers

Analysis of the French Chauviere Mechanically Operated Propeller. John D. Waugh. A design analysis is given of a type of controllable-pitch propeller designed by the French firm of Chauviere. This propeller is 11 ft. in diameter and has three dural blades. Power derived from the reaction between propeller rotation and the fixed engine nose case is used to achieve a pitch change. Brake drums retained on the rear of the hub and geared through an epicyclic train to the blades cause blade displacement when a brake shoe fixed to the nose case is actuated to stop their rotation. Sections of the article discuss the gear-train operation, gear-box construction, brake-drum construction, pitch-limiting system, hub design, and method of mounting the blades. *Industrial Aviation*, May, 1945, pages 36–38, 40, 42, 94, 15 illus.

Radio

A Radio Manufacturer Looks Out in Front. R. E. Samuelson. A manufacturer of aircraft radios reviews some of the problems of merchandising radio equipment for postwar personal aircraft. He discusses factors of lower costs, quantity production, specialized service, and assistance in installation and maintenance. He also describes some of the radio equipment that his company is planning to market. *Aero Digest*, June 15, 1945, pages 74, 75, 114, 6 illus.

The Omnidirectional Range. D. M. Stuart. This is a progress report on the development of the omnidirectional radio range, presented with a view to affording additional background material. It includes an outline of the principles followed in the development of the range as well as a description of the design and operation of the various units comprising the necessary equipment. The statement is made that progress has taken such a promising turn that omnidirectional V.H.F. ranges will probably supersede the two-course V.H.F. ranges in about a year's time. At the present stage of development, the omnidirectional range is said to be capable of an overall accuracy of approximately 3° and to go farther than any device so far proposed in providing a continuous indication of the azimuth in all directions without ambiguity. *Aero Digest*, June 15, 1945, pages 76, 77, 150, 5 illus.

Research

Trimming Research to the Postwar Pocketbook. Part VI. K. R. Jackman. Sixth article in a series analyzing the meanings, values, and problems of research as they relate to the aircraft industry. This article is concerned with the economics of operating research laboratories. It discusses the financial problems involved, estimating the amounts to be spent for research, and the determination of the ratio of research expenditures to gross income. Emphasizing the value of a budget as a guide for operations, the writer cites specific budget figures and advises on an approach to efficient cost accounting and operational control systems. Although his chief consideration is aircraft research organizations, many of the conclusions offered are based on developments by research organizations in the iron, steel, automotive, and other basic industries. A bibliography accompanies the article. *Aviation*, June, 1945, pages 141–146, 12 illus.

Rotating Wing Aircraft

First Roadable Helicopter Completed in Los Angeles. Scholer Bangs. Some particulars are given about a prototype model of a roadable helicopter which is reported to have been completed in Los Angeles. Called the "Flymobile," this two-passenger, 90-hp. helicopter with coaxial counterrotating rotors is the product of Curtis Wright Industries (not connected with the Curtiss-Wright Corporation) and was designed by Dr. E. W. Kay. It is stated to be similar in general appearance to the Hiller-Copter, flown last year. The method of flight control, however, is different. *Aviation News*, July 2, 1945, pages 12, 14, 2 illus.

Principles of Rotary Wing Aircraft. Part III. Alexander Klemin. In the

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third section of a serial article, the writer reviews briefly the experiments of C. N. H. Lock and the calculations of H. Glauert with respect to wind-tunnel tests of helicopter rotors. The results of the tests and the calculations are plotted and tabulated, and the pertinent equations are given. In the table the results have been converted to units in current use, so that the solidity ratio is partially removed as a parameter and the results of different experiments are made more comparable. The derivation of the Figure of Merit also is tabulated. The writer draws six conclusions from an inspection of the curves and tables, with regard to the comparison of experimental values and calculated values, and gives two examples. He then reviews the results of early propeller experiments at Stanford University, Howard O. Snyder's experiments in static thrust, experiments by Fage and Collings, and the work of Knight and Hefner. His conclusions are summarized under twelve headings, and seven problems that the reader can solve on the basis of the information given in the article are stated. *Aero Digest*, June 1, 1945, pages 82–88, 144, 146, 9 illus.

Stress Analysis

Plastic Bending—Further Considerations. Wm. R. Osgood. The problem of plastic bending under the assumption of realistic stress-strain relations has been considered in a previous paper. Since that paper was written, new ideas have occurred to the writer. These ideas lead to a general relation between moment and curvature for sections the widths of which are expressible as polynomials of any order. Specific solutions are given for five symmetric cross sections, including two sections bounded laterally by arcs of parabolas, and for six unsymmetric cross sections, including the triangular section and two sections bounded laterally by arcs of parabolas. It is planned in a subsequent paper to present an approximate solution of the problem of plastic bending. *Journal of the Aeronautical Sciences*, July, 1945, pages 253–262, 272, 11 illus.

The Relation of Stress to Strain in Magnesium Base Alloys. E. J. Eastman, J. C. McDonald, and A. A. Moore. Stress-strain curves to the yield strength are given for most of the commercially available forms of magnesium base alloys. For the high-strength wrought alloys, typical curves based on tests of large numbers of different lots are presented. The curves for the other materials are the averages of a few tests on one lot.

The values obtained for the modulus of elasticity were found to be a sensitive function of the testing technique. With careful testing, the values were distributed quite closely around a mean of about 6,500,000 lbs. per sq.in. This figure should be used in normal design calculations.

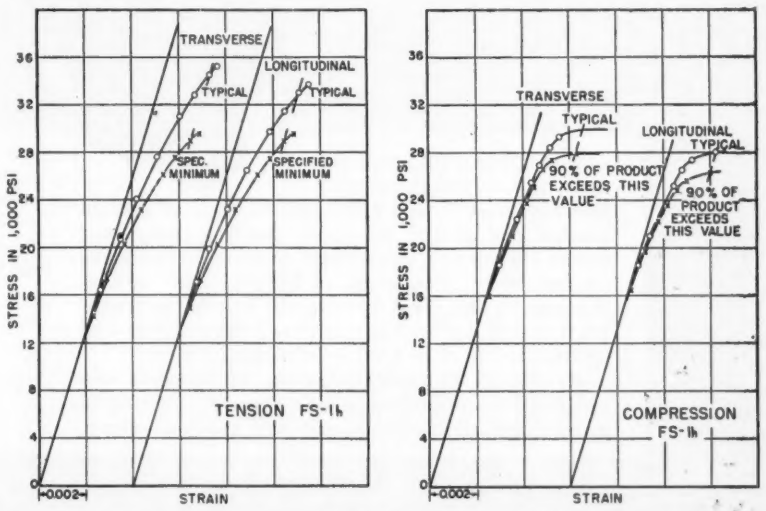
The ratio of compressive yield strength to tensile yield strength is close to unity for the high-strength wrought alloys and for the casting alloys. It is substantially less than unity for the lower strength wrought alloys. *Journal of the Aeronautical Sciences*, July, 1945, pages 273–280, 28 illus.

The Buckling of Sandwich-Type Panels. N. J. Hoff and S. E. Mautner. Fifty-one flat rectangular sandwich-type panels were tested in edgewise compression with the unloaded edges of the panels restrained by V-grooves. The sandwich consisted of papreg faces and a cellular cellulose acetate core. The thickness of the faces varied from 0.00675 to 0.02025 in.; the core, from 0.066 to 0.741 in.; the width of the panel, from 4 to 11 in. The length of the panel in all cases was 10.5 in. The buckled shape consisted of a ripple of short wave length across the panel. It was either symmetric, the two faces bulging out symmetrically according to sine curves, or skew, the two faces deflecting in the same sense according to sine curves having a phase angle of 90°.

A strain energy theory of buckling is presented for both the symmetric and the skew cases, and the buckling load in the symmetric case is also calculated by integration of the differential equation. The agreement between the theoretic and the experimental buckling stress is reasonable, that between the predicted and actual buckled shape good. A simple formula is developed which permits a choice of the most suitable core material when the mechanical properties of the face material are given. *Journal of the Aeronautical Sciences*, July, 1945, pages 285–297, 16 illus.

The Stress-Area Method of Designing Beams. Gilbert C. Best. A method is developed to facilitate the design of structures having zero margins of safety in bending. It is intended primarily for use with sections composed of many elements, such as wing and fuselage sections, in which each trial computation is a long and tedious procedure. A method of computing the amount of area required at selected points to obtain preselected stresses is worked out. The method makes use of section properties already obtained, thereby reducing the amount of computation necessary and facilitating the development of zero margin of safety with attendant minimum weight. The method is general in principle and can be extended to cover any indeterminate structure—e.g., a frame or a truss. Only the case of a section in bending is discussed in this article, however. Two examples are given. *Journal of the Aeronautical Sciences*, July, 1945, pages 298–304, 3 illus.

Correction of Aluminum-Alloy Compressive Test Results for Material Properties Using Reduced Moduli. Jacob Karol. This paper presents a method of correcting compression test results of aluminum alloys for variation of test material properties from standard, similar to Fig. 1–4 of ANC-5. The method uses column curves based on reduced moduli. Correction curves are given for 24S-T Alclad sheet and 75S-T Alclad sheet. A comparison of results using these curves with those obtained using Fig. 1–4 of ANC-5 is given which indicates differences less than ±2 per cent for test ultimate compressive stresses exceeding 70 per cent of the compressive yield stress of the test material, and maximum differences ranging from +8.7 to −4.1 per cent for test ultimate compressive stresses that are between 50 and 60 per cent of the compressive yield stress for the test material. The small differences shown for stresses above 60 per cent of the compressive yield stress are inherently caused by using different column formulas, while the rather large differences



(Left) Typical tensile curves, Dowmetal FS-1h sheet. *(Right)* Typical compressive curves, Dowmetal FS-1h sheet.

shown for stresses below 60 per cent of the compressive yield stress are primarily caused by the erroneous use of the test column curve formula given for calculating stresses beyond its point of intersection with the Euler formula.

While the curves presented in this paper apply directly to sheet-stiffener combinations using formed sheet stiffeners, it is believed that they are sufficiently accurate for sheet-stiffener combinations using extruded stiffeners. *Journal of the Aeronautical Sciences*, July, 1945, pages 305–310, 328, 3 illus.

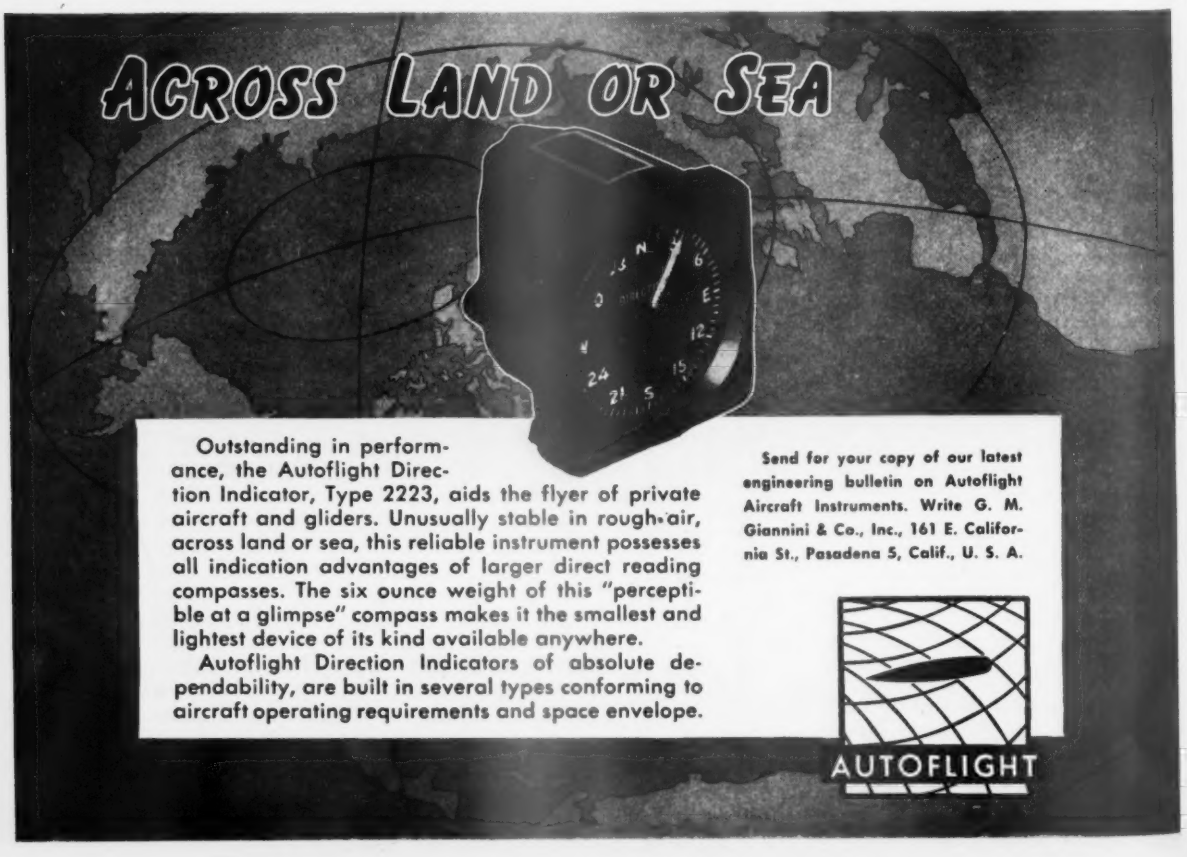
Strength of Magnesium Alloy Columns. F. A. Rappleyea. In order to present data for designing magnesium-alloy columns, tests on round bars of various commercial magnesium alloys were made. Two sets of end conditions were used—pin-ended and flat-ended. The pin-ended tests were conducted using carefully machined semispheric ends, a modified version of a jig proposed by J. A. Van den Broek. The flat-ended tests were made between two closely ground platens.

Various types of formulas were studied as to applicability for design use. It was found that Van den Broek's limit stress formula or a straight line formula where the constants depend upon the alloy used may be used to predict the column strengths of magnesium alloys if secondary failure does not occur. At certain values the Euler formula is used rather than the straight line formula. Values of the various constants used for different commercial magnesium alloys are given. *Journal of the Aeronautical Sciences*, July, 1945, pages 339–344, 12 illus.

Curved Aluminum-Alloy Sheets in Compression for Monocoque Constructions. Georges Welter. This study is intended to throw some light on the mechanical behavior of thin light-alloy sheets under compression and to give some explanations about the minimum load that thin-walled structures can support under axial thrust. The general idea of this investigation was to explore the field of rather unusual and delicate compression tests of panels up to the buckling load. Simple and time-saving tests were planned, and it was hoped to connect the results found during this investigation with the experimental and theoretic work of other authors (Cox, von Kármán, Redshaw) and to find a common basis for the interpretation of the results. The tests were conducted on a 60,000-lb. capacity Baldwin-Southwark Tate Emery universal testing machine, with a guaranteed accuracy of less than $^1/_2$ per cent of the load. The range used for most of these tests with the light metal alloy was of 2,400-lb. capacity with 2-lb. dial division. The accuracy of the machine was verified before the beginning of the main test series, and the degree of the stiffness of this type of testing machine was recorded.

After a description of the testing machine and the materials used, the writer gives the results of the tests and discusses at length the information derived. He concludes with a comparison of the theoretic and experimental results. *Journal of the Aeronautical Sciences*, July, 1945, pages 357–369, 19 illus.

Buckling of Plates with Intermediate Rigid Supports. Eric Reissner. The preparation of this brief note was suggested to the writer by a paper by E. Saibel on "Buckling Loads of Beams or Plates on Continuous Supports," appearing in the JOURNAL OF THE AERONAUTICAL SCIENCES for October, 1944. It is shown that results can be obtained for the problems under consideration which are natural extensions of the Weinstein-Trefftz procedure for the buckling and vibrations of the rectangular plate with clamped edges. These results are valid for rectilinear, as well as for curvilinear, rigid intermediate supports. The supports may be concentrated in a number of points along lines or distributed over portions of the plate area. Only the formal aspects of the problem are discussed and no actual applications of the formulas obtained are made. The difference between Saibel's and the present approach may perhaps be characterized by saying that the former assumes the constraints accurately and intends to solve the problem approximately, while in the present note constraints are assumed which approximate the real constraints and the resultant problem is solved rigorously. *Journal of the Aeronautical Sciences*, July, 1945, pages 375, 376.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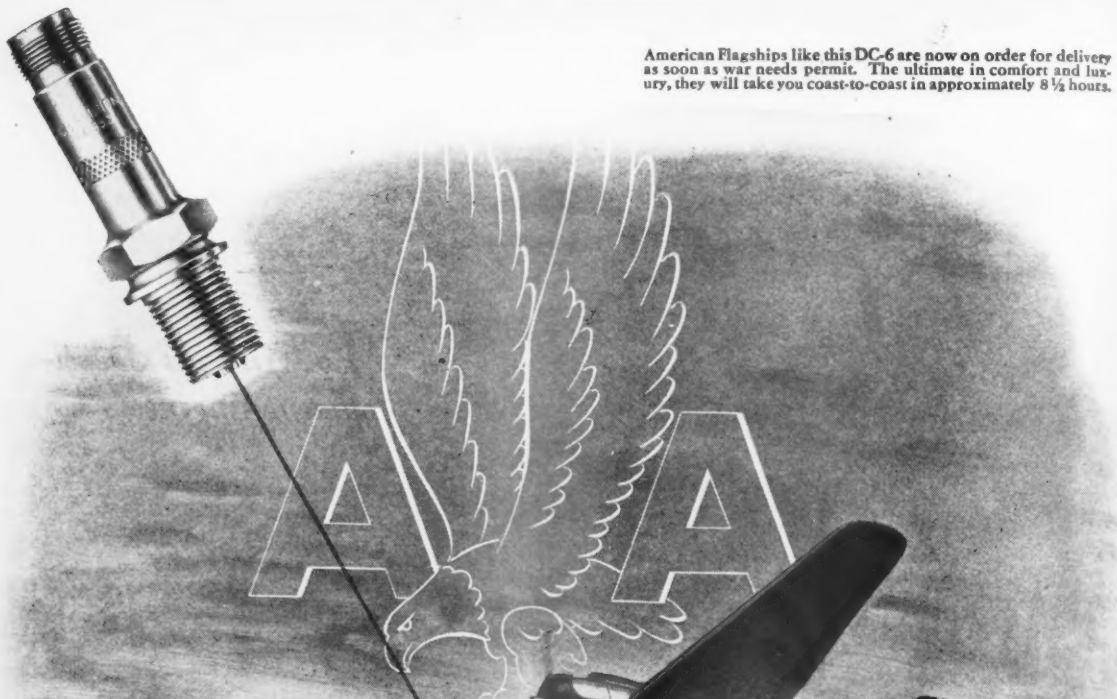

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How to Measure Stresses in Machines. B. F. Langer. The writer reviews the more important methods now available for the experimental solution of stress problems that cannot be solved by analysis alone. He describes the functions and the use of the three common methods, mechanical, optical, and electrical, and gives brief discussions about the various testing instruments and how they are used. Consideration is given to strain gages and applications for which they are suitable, two-dimensional stress patterns, and the application of mechanical gages to dynamic conditions. *Machine Design*, June, 1945, pages 123–127, 8 illus.

General Circular Ring Analysis. Leon Beskin. The writer presents tables and summarizes formulas that are required for the analysis of circular rings, under forces in the plane of the ring or out of the plane. Usually, rings that are redundant structures are calculated by considering strain attributable to bending only. It is shown that for the stress distribution in a circular ring under given loads, the solution introducing strains caused by shearing and axial loads is the same as the solution conventionally used. For the determination of ring deflections and for determination of redundant structures comprising a ring, it is necessary to determine deflections under all loads. Tables are given which summarize those deflections, presented as strain energy coefficients for any pair of given loads. It is shown that deflections due to shearing loads may be important and even greater than deflections due to axial loads. *Aircraft Engineering*, May, 1945, pages 126–132, 12 illus.

Correlation Studies of the Strength Characteristics of Alclad Sheet. I. G. Bowen. Reference is made to the increased attention that is being given to statistical variations of the strength of aircraft materials because of the importance of maintaining a high strength-weight ratio in design structures. Notes are presented on the characteristics of Alclad sheet conforming to specification DTD 390. Two aspects of the material are discussed. The correlation between proof stress and ultimate stress is examined because both these values are required in control testing as well as in design calculations. A similar examination of elongation and ultimate stress is made. The material used to provide the data was drawn at random from the stocks of various manufacturers, and the thicknesses of the sheets varied from 10 to 24 S.W.G. Results are tabulated. *Sheet Metal Industries*, June, 1945, pages 992–994, 1,000.

Torsional Rigidity Calculations for Waffle Type Construction. John H. Meyer. A report is given about the computed torsional deflections in a specimen airplane door of waffle type and spot-welded construction, compared with actual tests. It shows that the measured deflections are considerably greater than those obtained by calculation. To overcome this discrepancy, a new method of calculating deflections is suggested. The tests are described in detail with the necessary formulas, and the causes of the different deflections are analyzed. *Product Engineering*, June, 1945, pages 393, 394, 3 illus.

The Effect of Transverse Shear Deformation on the Bending of Elastic Plates. Eric Reissner. The writer develops a system of equations for the theory of bending of thin elastic plates, which takes into account the transverse shear deformability of the plate. This system of equations is of such nature that three boundary conditions can and must be prescribed along the edge of the plate. The general results of the paper are applied (a) to the problem of torsion of a rectangular plate; (b) to the problems of plain bending and pure twisting of an infinite plate with a circular hole. In these two problems important differences are noted between the results of the present theory and results obtained by means of the classical plate theory. It is indicated that the present theory may be applied to other problems where the deviations from the results of classical plate theory are of interest. Among these other problems is the determination of the reactions along the edges of a simply supported rectangular plate, where the classical theory leads to concentrated reactions at the corners of the plate. These concentrated reactions will not occur in the solution of this problem by means of the theory given in this paper. *Journal of Applied Mechanics*, June, 1945, pages A-69–A-77, 2 illus.

Short-Time Static Tests and Creep Tests of a Paper Laminate. W. N. Findley and W. J. Worley. The tests reported in this paper were undertaken to provide information concerning the static strength and creep characteristics of high-strength paper laminates used as aircraft materials. The laminates are made from special Mitscherlich paper impregnated with special resins and molded at low pressure. Three examples of such applications are aircraft wing tips, ammunition boxes, and fuselage sections. Details are given about the tests, with extensive information concerning the materials from which the specimens were made, and the apparatus used in the tests. Reports are made at length concerning short-time tension tests, short-time compression tests, and short-time torsion tests. The causes of failure are analyzed, static tests are compared, and a full description is given of long-time tension creep tests. The results are tabulated and recorded in charts, and some of the test operations are illustrated. *Modern Plastics*, June, 1945, pages 143–150, 190, 192, 194, 16 illus.

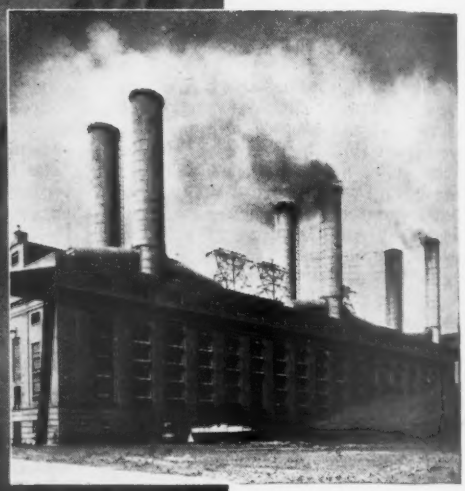
Fatigue Tests of Airplane Generator Brackets with Special Reference to Failure of Screw Fastenings. A. M. Wahl. A description is given of fatigue tests on forged-steel airplane-generator brackets of different proportions. It was found that in many cases the limiting factor in the strength of the assembly was not that of the bracket itself but rather that of the screw fastenings used to hold the bracket to the generator frame. It is noted that the fatigue strength of these screw fastenings is largely dependent on the rigidity (or thickness) of the bracket rim, since a flexible rim allows a high variable stress to be set up. Methods that appear to yield reasonable results for design purposes are given for calculating screw stresses, as well as spoke and rim stresses in brackets of this type. *Journal of Applied Mechanics*, June, 1945, pages A-113–A-122, 20 illus.

Deflections in a Square Plate With Two Adjacent Fixed Edges. By the use of difference equations the writer obtains a solution for the moments and deflections in a square plate with two adjacent edges fixed and the other two edges unsupported, for a concentrated load acting at various points on the diagonal bisecting the angle between the supported sides. For one position of the load, namely, at the center of the plate, moments are determined also for the supported edges hinged as well as fixed. Computation factors for the moments and deflections are tabulated. *Product Engineering*, June, 1945, pages 395–397, 2 illus.

Problems of Vibration Frequency in Beam and Tubing Members. C. R. Freberg and E. N. Kemler. Charts, tables, and explanations are given for the determination of the natural frequencies of various structural members. The method is described by reference to suitable formulas and examples are worked out with the aid of two tables and two charts. One example is the finding of the natural frequency of an aluminum control tube for aircraft use and another refers to the bending frequencies of a helicopter blade. *Aero Digest* June 1, 1945, pages 102, 103, 2 illus.

Shifting Origins—a Computation Saving Device. Alfred S. Niles. The writer shows how some otherwise tedious computations in shifting origins can be greatly shortened and the likelihood of numerical errors reduced by the simple mathematical device of shifting the origin of coordinates. This is illustrated by numerical examples dealing with the computation of the strain energy of a beam and the computation of the deflection of a point on that beam by two separate methods. These computations are given in detail so they can be followed by anyone with a knowledge of algebra. Advantage is also taken of the opportunity afforded by these examples to illustrate more convenient methods of handling some types of computation that are often carried out by inefficient procedures, particularly the determination of the reactions of, and bending moments on, a beam subjected to a complex lateral loading, and the computation of the deflection of a beam by the method of successive integration. *Industrial Aviation*, May, 1945, pages 62–64, 95–97, 3 illus.

Huge 12,500 HP boilers used in generating plants have tubes rolled and expanded into headers,—the same method responsible for the ruggedness of Fedders Aluminum Oil Coolers for aircraft.



HIGH PRESSURE BOILER STRENGTH in FEDDERS Aluminum Oil Coolers for Aircraft

EXACTLY the same principle of tube and header assembly used in huge high pressure boilers for electrical generating plants, is responsible for the extreme ruggedness of Fedders Oil Coolers.

Mechanically rolling and expanding tubes into headers has long been accepted as one of the strongest and most dependable pressure joint fabrication methods in engineering practice.

Advantages which result in the ruggedness of Fedders aluminum Oil Coolers for aircraft include—

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4. In case of damage in service, tubes can be replaced in a few minutes, and face leaks repaired in a matter of seconds. Thus it is no longer necessary to plug up leaky tubes with consequent performance loss.

Fedders Aluminum Oil Coolers have been flying in world wide extremes of weather and altitude for years. Engineers are invited to write for details on application of Fedders oil cooler designs to their specific installational requirements.

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Testing

The Miles Messenger Survives Impact Testing. Testing methods employed by Miles Aircraft, Ltd., to demonstrate the M.38 Messenger's resistance to impact are described. The article also contains a list of figures pertaining to the principal particulars and performance of this four-seater, low-wing light plane. *Canadian Aviation*, June, 1945, pages 84, 85, 2 illus.

Tools and Equipment

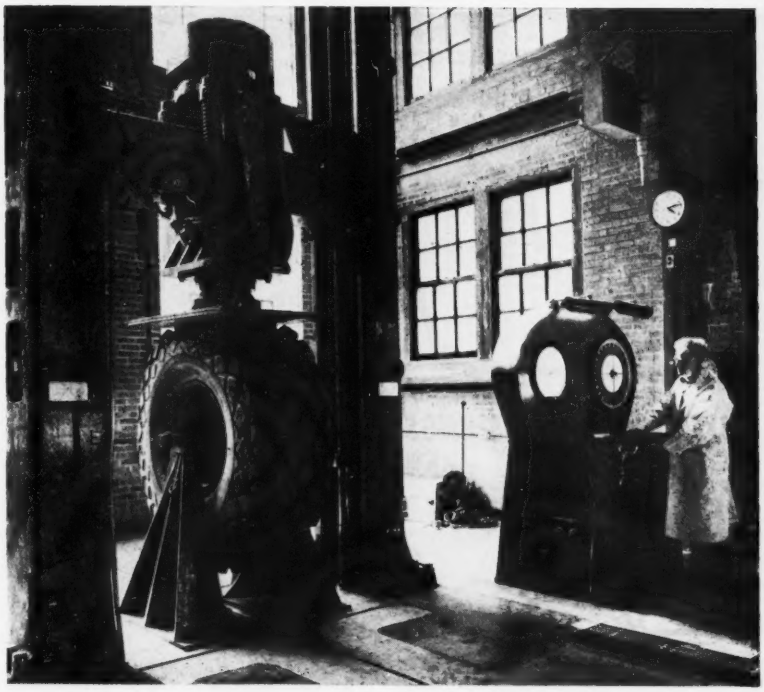
A Transfer Strain Gage for Large Strains. Martin Greenspan and Leroy R. Sweetman. A description is given of a simple and inexpensive strain gage, suitable for the measurement of strains from −16 to +32 per cent on a 1.5 gage length. This strain gage has been devised and successfully used by the National Bureau of Standards for the determination of the stress-strain relations in the plastic range of some aluminum alloys and steels. Particulars are given about the construction, operation, and accuracy of the gage. *Journal of Research of the National Bureau of Standards*, June, 1945, pages 595–597, 4 illus.

"Robot Giraffe" Gentled by AA. John O'Donnell. A description is given of a portable aircraft work stand for use in hangars, which is hydraulically operated and easily adjustable to different heights. It is called the Aerostand and was developed by the Pacific Engineering Corporation, of Los Angeles. Information is given about modifications in this stand which were introduced by American Airlines to make it still better for overall use in their hangars. *Air Transport*, June, 1945, pages 40, 41, 3 illus.

The Design of Balancing Machines. F. Campbell Rose. The balancing of rotating parts and the design of machines for balancing them are discussed. The conditions under which rotating parts may be out of balance are described. Consideration is given to the design and use of static and dynamic balancing machines. Information is supplied about various systems using electrical pickups to detect the movement caused by unbalance in a flexibly mounted rotor. *Aircraft Engineering*, May, 1945, pages 149–152, 11 illus.

Training

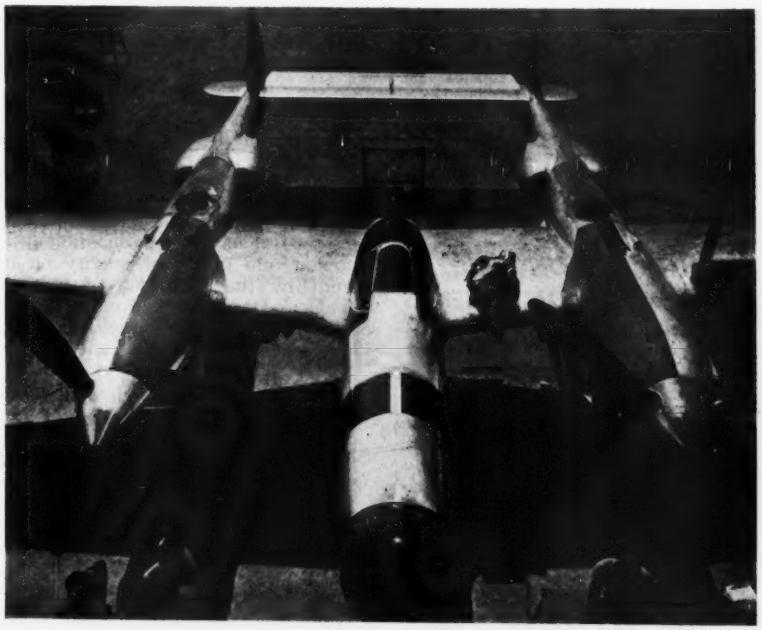
The Utilization of Industrial Reference Material in Aeronautical Engineering Training. M. J. Thompson. This article discusses industrial reference material that the instructor may use to advantage when endeavoring to build up a sound and progressive body of material for his courses. Items enumerated include industrial drafting and design manuals, standard parts books, equipment and material handbooks and catalogs, drawings and problems illustrating industrial practices and applications of fundamental principles, and handbooks and technical reports of the military services. Suggestions are given regarding the effective use of this material. *The Journal of Engineering Education*, May, 1945, pages 526–529.



Photograph Courtesy Goodyear Tire & Rubber Company

One of the world's largest tire-testing machines, used to conduct deflection and other tests on large pneumatic tires for airplanes. It is hydraulically operated and can exert a pressure up to 6,000 lbs.

Making a Strip Film. C. B. Colton. This article describes how the Sperry Gyroscope Company has found it possible to produce at a low cost its own strip film for use in campaigns to encourage factory employees to wear protective eyeglasses. Information is given about the



The P-38 Lightning Pathfinder, a modification of the fighter, has special navigating equipment in the nose enabling it to aim bombs for an entire bombing group.

Pre-view of tomorrow's plane

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way the film is made and used with success. *Factory Management and Maintenance,* June, 1945, pages 98, 99, 3 illus.

Frenchmen. William D. Strohmeier. An account is given of the flying instruction program conducted at Hawthorne Field for French air cadets. The report not only describes the methods employed to circumvent interpretation difficulties and other special problems but also contains an evaluation of the French cadets' flying abilities and aptitudes. *Air Facts,* July, 1945, pages 22–26, 1 illus.

The Scope and Aims of Civilian Aero-Medical Courses and Their Relation to Engineering. F. R. Steggerda and M. K. Fahnestock. The requirements for civilian aeromedical courses are discussed and their relation to engineering is considered. Reference is made to problems that the Army and Navy have had to meet in teaching pilots to fly at high altitudes. It is stated that the problems were many and difficult, but through concerted effort on the part of physiologists, psychologists, physicists, and engineers, great advances have been made. It is also stated that the future of the aircraft industry depends largely upon the ability of engineers to provide aircraft that are inexpensive, reliable, and simple to operate for a large number of potential personal fliers. They must fit the machines to certain economic and personnel limitations. *The Journal of Engineering Education,* May, 1945, pages 522–525.

Training the Private Pilot. Contaire. In this commentary the somewhat haphazard method of training private pilots before the war are outlined. Changes in methods of flying education which have taken place in recent years are described. Consideration is given to future training requirements for the private flier. *Aeronautics,* June, 1945, pages 46–48.

Weight Control

Weighing and Locating the C.G. Part I. F. D. Porter and W. W. Holtz. This is the beginning of a two-part article on the determination of the weight and center of gravity of aircraft by the utilization of weighing scales. Attention is given to the requirements for scales, which, it is noted, must be accurate and of adequate capacity.

Types of scales for airplane weighing are discussed. It is stated that the lever type of platform scale has proved most satisfactory. Reference is made to difficulties encountered in the development of small portable weighing equipment. It is stated that these difficulties are gradually being eliminated, and that in the future equipment capable of handling the most complex weighing jobs should be available.

Emphasis is placed on the importance of the weighing location, which should be level and free from draft. Scale installations, types of handling equipment, and weighing procedure are discussed. *Industrial Aviation,* June, 1945, pages 51, 52, 54, 55, 6 illus.

Welding

Welding Aluminum-Magnesium Alloys. W. K. B. Marshall. When welding some aircraft fuel tanks constructed in 20 S.W.G. 3 per cent magnesium alloy it was found that serious cracks of a particular type occurred. The writer discusses the effect of grain size on the occurrence of cracks and describes the procedure developed to solve the specific problem. It is noted that the problem may be encountered in any fabricating process in which working and annealing is followed by welding.

It is stated that the reason for the general tendency of aluminum-magnesium alloys to crack in welding appears to be due to the rapid deterioration in the strength of the grain boundaries at elevated temperatures. *Transactions of the Institute of Welding,* May, 1945, pages 53–57, 9 illus.

The Welding of Non-Ferrous Metals. Part V. E. G. West. Welding procedures as applied to the various nonferrous metals and alloys are further discussed in this installment of a serial article. Consideration is given to arc welding processes. The fundamental aspects of arc welding are discussed in sections dealing with temperature, arc voltage, arc blow, penetration, heat distribution, and arc stability.

Information is given about metallic arc welding. *Sheet Metals Industry,* June, 1945, pages 1057–1063, 8 illus.

Miscellaneous

Eightieth Annual Report of the Council, 1944–1945. The 80th annual report of the Council of The Royal Aeronautical Society reviews the activities of the Society for the 1944–1945 fiscal year. It contains a report of the Annual General Meeting held on March 27, 1944, and a Special General Meeting held on February 5, 1944, as well as the lists of honors and awards conferred, lectures given, and officers and committees of the Society. The financial reports are published in full, and figures showing the different classes of membership are tabulated. *The Journal of The Royal Aeronautical Society,* May, 1945, pages 251–267.

Commercial Aviation's Sixth Annual Aircraft and Engine Review, 1945. A photograph accompanies each condensed description in this sixth annual compendium of aircraft and aircraft engines. The products surveyed include airplanes, gliders, helicopters, and engines of American, British, and Canadian manufacture. *Commercial Aviation,* May, 1945, pages 55–112, 205 illus.

Northwest Airlines joined the coast-to-coast group of American air carriers on June 1, this year. Through their new service, New York and Detroit are linked to Washington-Oregon cities with fast, direct service given by Pratt and Whitney-powered, Douglas-built transports.

Thus, Northwest Airlines pioneers a new chapter in the air history of the great northwest. And AC is pleased that its ceramic aircraft spark plugs,—a *kind* of spark plugs which AC pioneered for World War I, —have been chosen to fire Northwest's engines. The Type LS-86, twin of thousands of AC Spark Plugs which have been serving the Army Air Forces since Pearl Harbor, is the standard plug of the new "Northwest Passage" by air.

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SPEED FINAL VICTORY — BUY WAR BONDS

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"You're an Angel...*with wings!*"

Ambulances fly in this war, and their flight brings swift evacuation of the wounded from the areas of front line danger. And because ambulances fly, the wounded are minutes, not days, from the clean sterile mercy of base hospitals.

Flying ambulances lend wings to the skills of doctors and nurses. For doctors and nurses and medical equipment go with the wounded in these hospital wards of the air. The skill of aeronautical engineers and medical science have thus combined to save lives and bring swift mercy.

Fairchild ingenuity, for example, gave the Army Air Forces the "Packet"—a plane in which men and machines can be carried into battle. But the "Packet" is a ship of mercy too, convertible *in a few minutes* to a plane ready to receive the victims of enemy action.

Known to the Army as the C-82, the long-range "Packet" can carry 34 litter cases, four attendants, and medical supplies. Cramped quarters do not hamper nurses ministering to the wounded. An ingenious litter suspension affords ample room for movement. So successful is this strap-suspension device, developed by Fairchild engineers, that it has become standard equipment on all types of planes used as flying hospitals.

Versatile in its applications, the "Packet" can do double duty as a mercy ship. It can carry the wounded from front line evacuation fields over long distances to base hospitals. Returning to the forward areas, it can carry up to *nine tons* of supplies needed at the front lines.

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Government Publications

Army Air Forces

Big Wheels. Lt. Elmer S. Bendiner. A history is given, in narrative style, of the development and quarterly revision of the Navigators' Information File, which is described as a manual that has become required reading for every navigator in the Air Forces. Its growth is traced from its origin as an unpretentious mimeographed form to its present importance as a compendium of data concerning navigation and navigation equipment. The officers and enlisted men who have contributed to the development of the publication are named and brief sketches are given of the careers of some of them. *Log of Navigation*, June, 1945.

Conveyor for Cleaning Engine Parts. Improvements in the overhaul of worn-out airplane engines have been made at Headquarters, Rome Air Technical Service Command, Rome, N.Y., through the use of a new automatic conveyer cleaning system in its engine repair shops. The new system is totally different because shortage of space caused R.A.T.S.C. engineers to deviate from straight conveyer lines and makes earlier methods outdated.

By designing the conveyer system in a series of turns, doubling it back on itself six times, overlapping some of the turns at different levels, and avoiding simultaneous horizontal and vertical turns, engineers have managed to fit the line, with its more than 400 ft. of tanks and washers, into a space no larger than 46 by 86 ft. The new system, installed in the Engine Repair Branch of the Maintenance Division, has eliminated one of the most disagreeable phases of large-scale engine repair work and has been largely responsible for relieving an acute labor shortage.

The new system, which works on an overhead chain-type conveyer belt, enables better cleaning of disassembled engine parts than by previous methods, and twice as fast. It also permits a more uniform processing of these parts, and at a predictable rate which formerly was impossible. The disassembled valves, pistons, cylinders, engine cases, springs, and the hundreds of other component parts of a modern radial power plant formerly were carried through a series of cleaning tanks for their preliminary cleaning. They were lowered individually or collectively, in baskets, into each of a number of tanks by monorail hoist. While this cleaned away most of the carbon and grime, the parts still had to be cleaned individually by hand after their tank baths. Now the parts are hung on the conveyer immediately as they come off the end of the disassembly line and are not touched by human hands again until they emerge from the other end of the line. This cleaning process takes a little more than 3 hours and does such a thorough job of cleaning the parts that further hand-cleaning is unn cessary. A limited number of employees is sufficient to take care of the entire line. A 2-hp. electric motor drives the line.

Aside from the conveyer, the principal elements of the cleaning line are four large tanks and three industrial spray washers. The entire line of tanks and washers is covered. The total capacity of the tanks is 28,660 gal. Two of the spray washers are single-stage industrial washers. The last is a large five-stage industrial washer. All were built by the Industrial Washing Machine Corporation, of New Brunswick, N.J. The 954-ft.-long conveyer was fabricated by the Lamson Conveyor Corporation, Syracuse, N.Y. *Air Technical Service Command.*

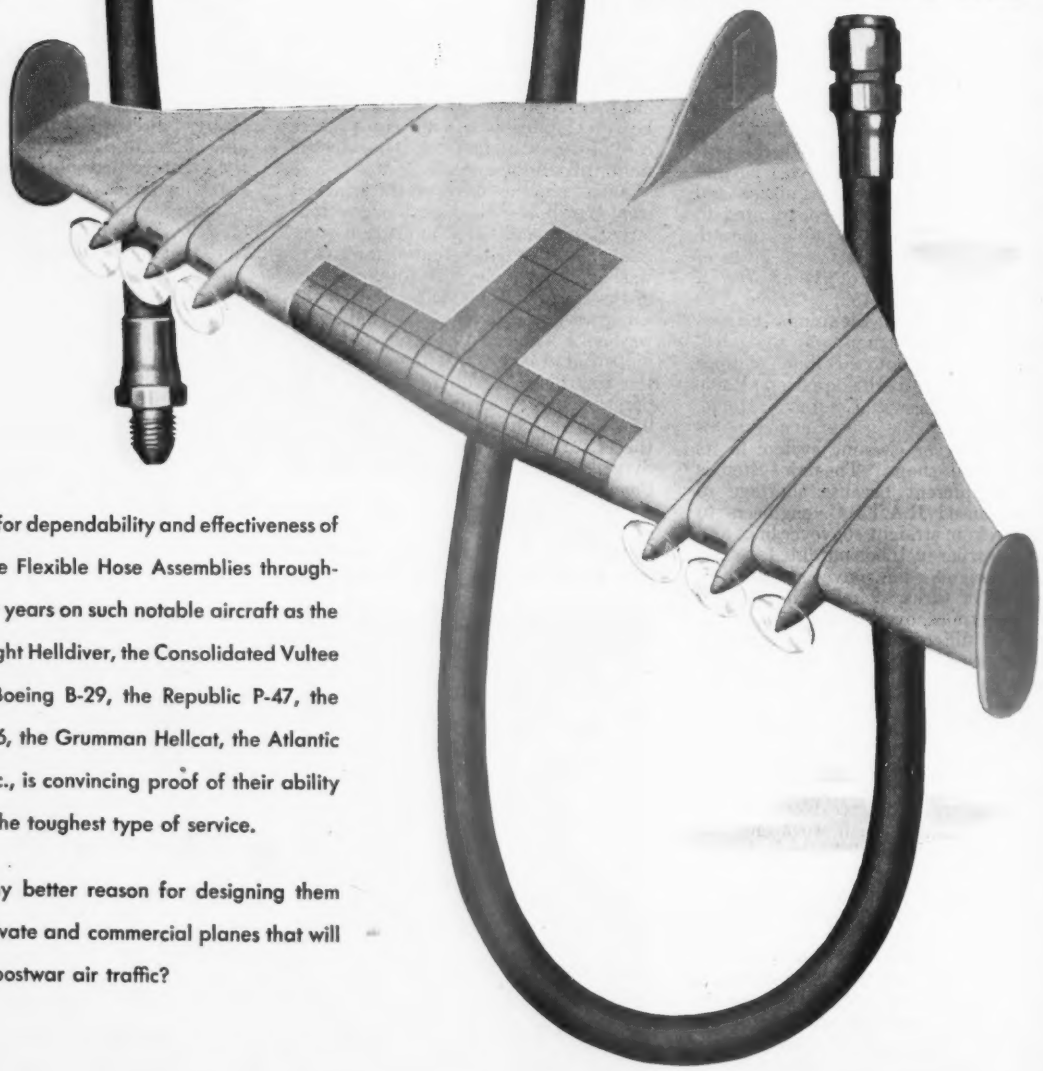
"Glip" Bombing. Lt. Col. George W. Taylor. The technique involved in the destruction of bridges with the least possible expenditure of bombs is described. The "glip" bombing technique, as it is called, consists essentially of a double-glide approach, that is, a steep glide followed abruptly by a shallow glide. The pilot aims at a point in front of the bridge and continues to glide until he reaches a low altitude where the glide angle abruptly decreases. While the plane is in the shallow glide, the modified gun sight (N-6), always preset before take-off, is used to aim at the bridge. The angle set into the sight is that obtained from skip-bombing tables, minus a correction to compensate for the glide angle. Bombs are released by the pilot from a low altitude with a smooth follow-through. The results obtained by this bombing technique are briefly analyzed and the destruction imposed on the enemy is summarized. The method was devised by a group operating in Burma under the command of Major Gen. C. L. Chennault. *Air Force*, June, 1945.

Tony, Nick, and Oscar 2. Capt. W. H. Cartter. Observations are made concerning the flight and combat characteristics of three fighter airplanes of the Japanese army air force, these airplanes being described as of later and better design than earlier Japanese fighters. Comparisons are made of

A top view of the Rome, N.Y., Air Technical Service Command's automatic conveyer cleaning system. The unorthodox design of the conveyer line permitted A.T.S.C. engineers to pack efficiently the more than 400 ft. of tanks and washers into a space only 46 by 86 ft.

POSTWAR AIRCRAFT

WILL BENEFIT FROM THE LESSONS OF THE WAR



The record for dependability and effectiveness of Flex-O-Tube Flexible Hose Assemblies throughout the war years on such notable aircraft as the Curtiss Wright Helldiver, the Consolidated Vultee B-24, the Boeing B-29, the Republic P-47, the Curtiss C-46, the Grumman Hellcat, the Atlantic Clipper, etc., is convincing proof of their ability to handle the toughest type of service.

Is there any better reason for designing them into the private and commercial planes that will carry our postwar air traffic?

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these recent enemy aircraft with some of the current American fighter planes from the standpoint of speed, rate of climb, maneuverability, and other characteristics. Although it is noted that in some respects these enemy aircraft appear to have certain superiorities, there are other respects in which they are deficient, as measured by U.S. design standards. Specifications are given for the construction, performance, and armament of the Tony, the Nick, and the Oscar Mark 2. *Air Force*, June, 1945.

U.S. Marine Corps

History of Marine Aviation. Prepared by Capt. W. H. Goodman. An outline in two booklets of Marine aircraft history—one gives the history of the First Marine Aircraft Wing from the date of its commissioning at Quantico, July, 1941, to December, 1944; the other gives the history of the Second Marine Aircraft Wing from July, 1941, to December, 1944. The story of the First Marine Aircraft Wing reviews difficulties encountered in obtaining equipment and trained personnel for the unit, and then proceeds to a review of the activities of the unit at Guadalcanal, New Georgia, Bougainville, Rabaul, the Philippines, and elsewhere.

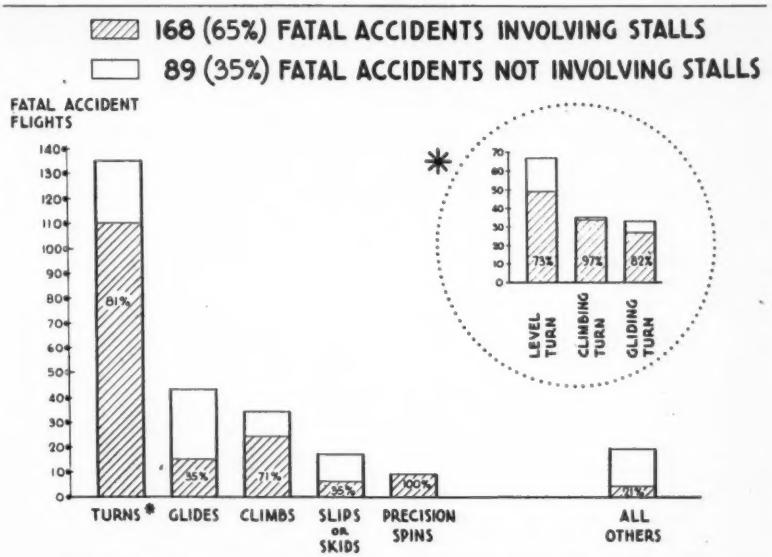
In a similar manner, the history of the Second Marine Aircraft Wing relates the achievements of the unit at Wake Island, Midway, Guadalcanal, New Georgia, Efate, Peleliu, and elsewhere. *Historical Division, U.S. Marine Corps*, Washington, D.C.

Civil Aeronautics Administration

Alphabetical Index of Specifications of the Airways Engineering Division and Signals Division. An alphabetical index is published to facilitate reference to specifications in regard to title of subject matter. It contains a list of the specifications of the Signals Division and Airways Engineering Division arranged alphabetically with reference to the corresponding C.A.A. specification numbers. *Office of Federal Airways*, Washington, D.C., January, 1945.

Systems of Approach-Light Aids. Information is given about six different types of airport-lighting approach systems that are being developed at the C.A.A. Experimental Station at the Indianapolis Municipal Airport. Tests are carried out by the C.A.A. in cooperation with the air lines, the electrical industry, the Army and Navy, and the National Bureau of Standards. Control equipment has been installed by which any one of the different lighting systems can be turned on or off from the control tower or from the field control station, and the lights can be varied in intensity, to make possible a great number of flying tests.

Among the instruments developed in the course of this test is a "transmissometer," an instrument that measures



This illustration from the report of the National Research Council to the Civil Aeronautics Administration indicates the causes of civil aviation accidents as determined from a study made during 1943–1944.

light absorbed or scattered by the atmosphere, thereby indicating visibility. Various other items of equipment used in this experimental work are described. *Office of Aviation Information*, June, 1945.

Aircraft Stand-By and Crash Procedure Manual. This manual prescribes the procedure to be followed in the event of aircraft stand-by or crash. It also specifies the duties and responsibilities of the C.A.A., the military authorities, the air lines, and other tenants at the Washington National Airport. After giving definitions of terms and the identifying markings of emergency equipment, the manual outlines the authority and responsibilities of various representatives at the airport, and then gives a detailed description of the procedure to be followed in the event of the emergencies specified. *Information and Statistics Section*, December, 1944.

The Aircraft Pilot. The results of 5 years of research carried out by the Committee on Selection and Training of Aircraft Pilots, National Research Council, are summarized in this report to the Division of Research, Civil Aeronautics Administration. Sections of the report are devoted to pilot selection and classification, pilot training, the evaluation of pilot performance, and the emotional disturbances associated with learning to fly. Studies of air sickness and aviation accidents are reported.

Long-Range Program of Improvements in Air Traffic Control. The sixth in a series of reports concerning the study of air-traffic control reviews briefly the program of present improvements and outlines a long-range program to be effected in the air-traffic control service. The report suggests the early adoption of a simple anticollision electronic device that would be inexpensive and easily installed in aircraft; it also contemplates the eventual use of additional ground electronic equipment, such as automatic position reporters and control indicating transmitters.

The main sections of the report deal with future methods of air navigation, developments now under way, developments in the international field, and future developments. *Federal Airways Service.*

Airport Facilities . . . Record System Manual. Instructions are given primarily for use in the preparation and maintenance of Forms ACA-29A and Q-29. The booklet contains definitions and instructions for reference according to the sequence of items of the Form 29A. Another part gives recommended requirements for standard sketches, the third part includes recommended regional procedures for control and assignments, and the fourth part gives detailed directions for the use of forms, procedures, and statistical services. *Information and Statistics Section.*

Flight Engineering Report No. 17, "The Apparent Effect of Pilot Technique and Atmospheric Disturbances Upon the Measured Rate of Climb of an Airplane." This report has been prepared by the Flight Engineering and Factory Inspection Division and is concerned with the precision that it is possible to obtain in the measurement of climbing performance of an airplane as influenced by the probable effects of pilot technique and atmospheric disturbances.

The investigation covered by the report involved a series of 101 separate attempts to measure the rate of climb, each by a different pilot, under conditions as nearly identical as it was found possible to obtain. There was also conducted a second series of 48 separate attempts, a majority by the same pilot, to measure the rate of climb in air of various degrees of roughness. The re-

port analyzes the results of these tests and draws certain conclusions concerning the precision with which the rate of climb may be measured and the nature of the atmospheric disturbances encountered during the testing. *Safety Regulation Release No. 181*, June, 1945. Available upon request to Aviation Information, Attention A-251, Civil Aeronautics Administration, Department of Commerce, Washington 25, D.C.

Airworthiness Directives, Airworthiness Bulletins, and Manufacturers' Service Bulletins. It is the purpose of this release to advise aircraft owners, manufacturers, operators, and other interested parties of a change in the procedure and method of issuing Airworthiness Directives, and related information concerning unairworthy conditions found to exist in certificated aircraft and corrective measures required to prevent their recurrence. This change is being made to eliminate certain disadvantages associated with the present system as well as to provide a simpler system that will be better adapted to the increasing civil aviation activity.

Effective immediately, the following system will be employed: (a) Airworthiness Bulletins will be consolidated with Airworthiness Directives under the latter heading. (b) Instead of "Inspection" and "Special" notes, the Directives will have "Mandatory" and "Service" notes. At the time each existing Directive is revised for any reason the notes therein will be changed to Mandatory or Service notes as applicable. Some of the existing notes may be deleted entirely if it is determined that they are unnecessary. (c) Manufacturers' Service Bulletins. Aircraft, engine, propeller, and equipment manufacturers should furnish five copies of all Service Bulletins to the Aircraft Engineering Office with which they normally deal. The Service Bulletins will be reproduced by C.A.A. for the use of its field personnel. Copies will not be available from this source for distribution to owners; however, they will be available for reference in C.A.A. general information libraries. Owners should arrange to obtain their personal copies of Service Bulletins from the manufacturers. In order that satisfactory reproduction may be made, it is desirable that at least one of the five bulletins furnished be extremely legible. It would be helpful if white paper were used and the typing, sketches, etc., were black. Also, if photographs are used in the bulletins and they are not clear, prints from the original negatives would aid greatly in making satisfactory reproductions.

Detailed explanations are given under each of the foregoing headings. *Safety Regulation Release No. 182*, June, 1945.

Specifications for Civil Aeronautics Administration Approved Aircraft Fabric Covering Material. This release contains the specifications for C.A.A. approved aircraft fabrics and the procedure for obtaining C.A.A. approval of fabrics meeting these specifications. The approved grades of fabric will be designated as grades CAA-1, CAA-2, and CAA-3.

Any fabric that can be shown to be the equivalent or better of one set forth in the specifications will be equally acceptable. In this regard, Army-Navy fabric Grade A conforming to Specification AN-C-121 is equivalent to grade CAA-1; Army Air Forces glider fabric conforming to AAF Specification 16128 is equivalent to grade CAA-3.

CAA-1 and CAA-3 fabric specifications are the same as presently outlined in CAM 04, Section 04.415, and CAM 18, Table 6, except for the addition of a minimum tearing strength. Grade CAA-2 fabric is intended to replace the indefinite "intermediate" fabrics as now included in CAM 04 and CAM 18.

Grade CAA-1 is the minimum fabric grade acceptable for use on aircraft having wing loadings of 9 lbs. per sq.ft. or over, or those that never exceed glide or dive speeds of 160 m.p.h. or over.

Grade CAA-2 will be acceptable for use on aircraft with wing loadings of less than 9 lbs. per sq.ft. or those that never exceed glide or dive speed of less than 160 m.p.h. Because of the short useful life and unsatisfactory service experience of lightweight fabric, the minimum tensile strength of fabric satisfactory for use on light airplanes is being raised from 50 lbs. per in. to 65 lbs. per in.

A 50-lb. grade of fabric (Grade CAA-3) is being retained for use on gliders with wing loadings of 8 lbs. per sq.ft. or less, or those that never exceed glide or dive speeds of 135 m.p.h. or less.

Specifications for fabrics to meet the requirements are given in text and tables, and the procedure for obtaining approval is outlined. *Safety Regulation Release No. 183*, June, 1945.

Civil Aeronautics Board

Annual Report of the Civil Aeronautics Board 1944. The first section of the 1944 annual report contains a brief outline of the year's activities and then presents a detailed survey of the work of the Board under the headings of Growth of Air Transportation; Expansion of Air Transportation; Special Matters; Economic Regulations; and Safety. A special section reports on operations in Alaska. Eleven appendixes contain detailed statistical information and tabulated figures.

Modification of New Part 60. The Civil Aeronautics Board has modified the provisions of new Part 60 of the Civil Air Regulations, Air Traffic Rules, scheduled to go into effect on August 1, 1945, so as to provide for contact flight against the base of the clouds up to 700 ft. instead of 1,000 ft. as provided in the revised Part recently adopted. The Board also changed the provisions of new Part 60 to permit instrument flights down to 1,000-ft. rather than 1,500-ft. minimum proposed in the new Part. The provision for a 1,000-ft. minimum for instrument flights is the same as in the old Part 60, presently in effect, and will therefore have no effect on present instrument procedure.

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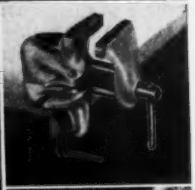
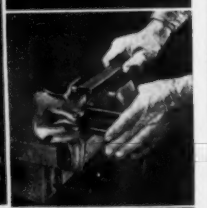
GRAND Speed QUIKCET VISE
CHECK THESE FEATURES
✓Instant Ratchet Screw Closing. Opens instantly with Trigger Release. No wasted time running screw in or out.
✓Balanced Precision Grip at all points. Hardened serrated jaws, integral with body — no jaw plates to come loose. Heavy guide rods.
✓Multiple Strength — Alloy-Steel extra thick wall body construction.
✓Anvil top. Bottom screw clamp for quick shifting of vise.



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30th Year
ENGINE COOLING RADIATORS
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OIL COOLERS
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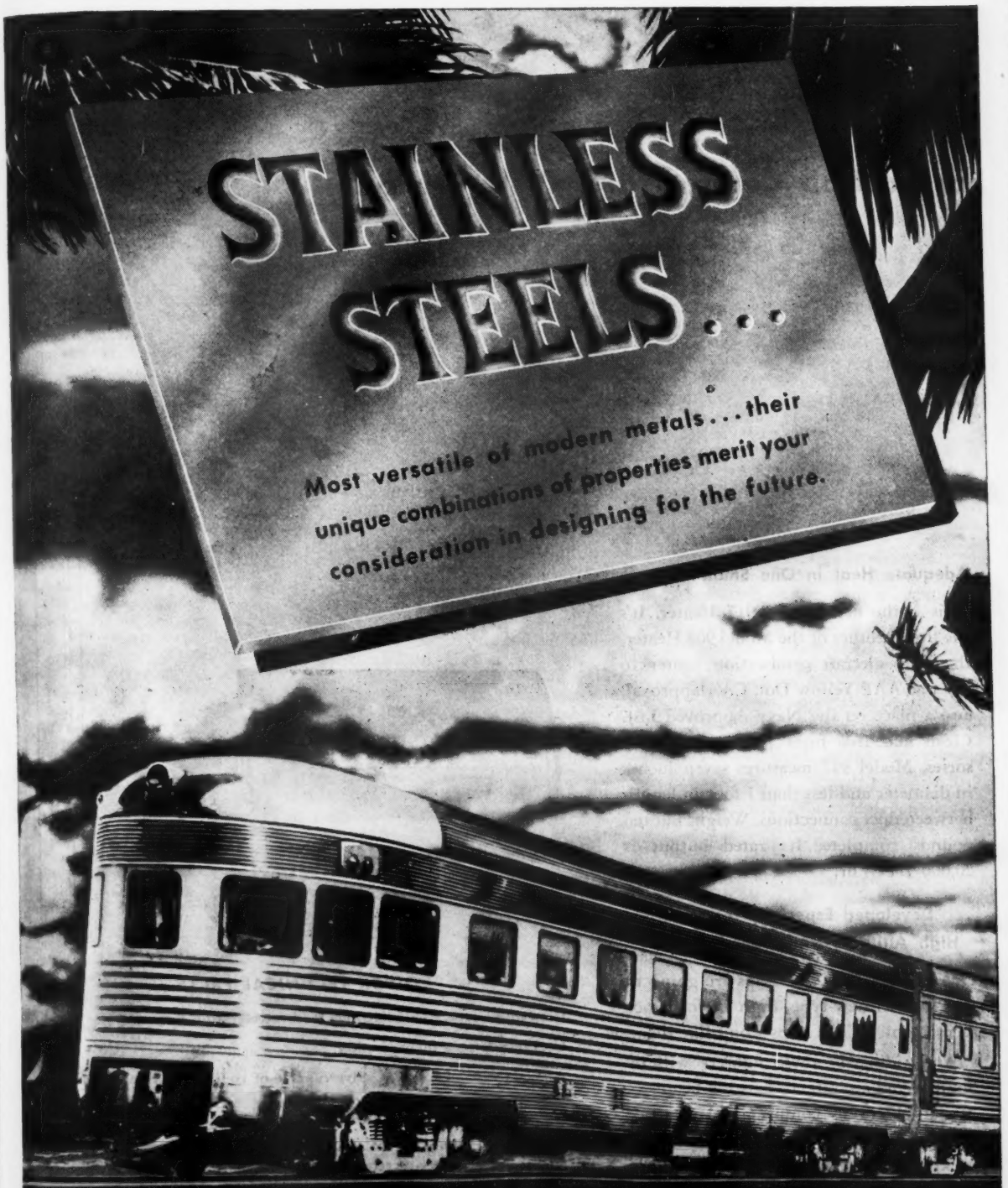
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Most versatile of modern metals . . . their unique combinations of properties merit your consideration in designing for the future.

● This Streamliner exemplifies the enduring strength and beauty of stainless steel. Characterized by endurance under corrosive conditions, chromium-Nickel stainless steels permit reduction of bulk and dead weight . . . without sacrifice of strength or safety.

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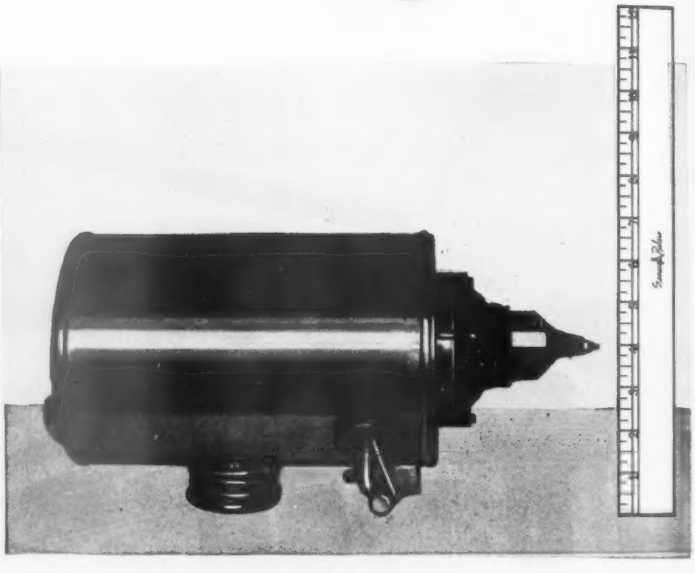
For Cockpit Comfort and Clear Vision

UP WHERE IT'S 50° BELOW



Adequate Heat in One Small Package

This is the new Model 917 Heater. It's the little brother of the Model 906 Heater, the only aircraft combustion heater to win the AAF Yellow Dot, CAA approval, and a place on the Navy Approved List. Clean and free from protruding accessories, Model 917 measures seven inches in diameter and less than 1 foot in length between duct connections. Weighs but ten pounds complete. Its rated output is 20,000 BTU/hr.

Developed Especially for New High Altitude, High Speed Fighters

One of these days, the Nips are going to tangle with new-type, high performance secret fighters. The Nips won't like them.

And riding in these fighters will be South Wind aircraft combustion heaters—Model 917. This compact little furnace provides adequate heat for simultaneous cockpit heating and windshield defrosting, even at the service ceiling of the plane, which is plenty high! It is equally applicable to lower performance aircraft.

QUICK TECHNICAL FACTS

1. Uses spiral type heat exchanger with accelerating flow.
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3. A combustion air-control valve capable of controlling ram air pressures at extremely high speeds, is contained within the heater case. No external combustion air connection required.
4. Uses same lightweight, reliable, glow coil ignition system that established fine service record on Model 906.
5. Combustion gases are contained within a one-piece, all-welded, hermetically sealed stainless steel enclosure, designed to minimize thermal stresses and add longer life.
6. Not affected by operating conditions of the airplane engine. Can easily be equipped with a blower to assure clear vision at take off through pre-flight heating of windshield.

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The Board's action came after a meeting held on June 26, when representatives of the C.A.A. and of numerous interested organizations met to adjust their differences of opinion concerning the Board proposal to set 1,500 ft. as the minimum altitude for instrument flights. As a result of the protests of many of these organizations concerning the 1,500-ft. minimum altitude, and because this particular provision of the regulation had not been circulated to the industry for comment before final action on Part 60 was taken, the Board on June 19 postponed the effective date of new Part 60 from July 1 to August 1, and arranged the meeting in Washington so that it might have the benefit of the opinions of all interested parties. On the basis of the views presented during this discussion the Board has authorized these revisions, which seem to fulfill more completely the needs of both contact and instrument flying at this time.

Commercial Air Transportation in Africa. A mimeographed bulletin of eight pages contains a review of air transportation in Africa during the war years and gives figures in text and tables concerning the air lines operating in Africa, the points served, the number of scheduled arrivals and departures, route mileage, and other statistics. Maps outline certain air routes and service frequency in Africa, and similar maps are available showing routes and frequency of air lines in Australia, Canada, Mexico, and parts of South America. *Air Transport Information Division, Economic Bureau,* May, 1945.

Department of State

International Civil Aviation Conference. The Final Act and Related Documents resulting from the International Civil Aviation Conference held at Chicago, November 1 to December 7, 1944, are available in booklet form. In addition to the complete text of the final act, including five appendixes and 12 annexes, the booklet contains reproductions of the invitation by the U.S. Government to the conference, messages from the President of the United States, a list of the officers of the conference, and of the members of the various delegations. *Department of State Publication No. 2282, Conference Series 64.* For sale by the Superintendent of Documents, Washington, D.C., $0.45.

Concerning Acceptance of Aviation Agreements as Executive Agreements. Stephen Latchford. This article deals with the Interim Agreement on International Civil Aviation, the International Air Services Transit Agreement, and the International Air Transport Agreement signed by delegates to the International Civil Aviation Conference held at Chicago, from November 1 to December 7, 1945. The writer reviews the legal authorities and precedents governing an agreement within the scope of the Chief Executive, which does not need to be approved by

the Senate in accordance with the provision of the Constitution relating to the treaty-making power. Such agreements are regarded as temporary arrangements pending a permanent system. Certain provisions of the Air Commerce Act of 1938 and other laws are examined with regard to the authority for regulating foreign commerce by air, and questions that might arise under these various laws are discussed. *Department of State Bulletin,* June 17, 1945. For sale by the Superintendent of Documents, Washington, D.C., $0.10 per single copy, $3.50 per year.

National Advisory Committee for Aeronautics

Mechanism of Flutter: A Theoretical and Experimental Investigation of the Flutter Problem. Theodore Theodorsen and I. E. Garrick. The results of the basic flutter theory originally devised in 1934 and published as N.A.C.A. T.R. No. 496 are presented in a simpler and more complete form convenient for further studies. The paper attempts to facilitate the judgment of flutter problems by a systematic survey of the theoretic effects of the various parameters. A large number of experiments were conducted on cantilever wings, with and without ailerons, in the N.A.C.A. high-speed wind tunnel for the purpose of verifying the theory and to study its adaptability to three-dimensional problems. The experiments included studies on wing-taper ratios, nacelles, attached floats, and external bracings. The essential effects in the transition to the three-dimensional problem have been established. Of particular interest is the existence of specific flutter modes as distinguished from ordinary vibration modes. On the basis of concepts introduced, results that are apparently paradoxical could logically be brought into conformity with the theory. In fact, it is shown that there exists a rather remarkable agreement between theoretic and experimental results. A simple method is presented for numerical calculations of the flutter speed by routine operations, requiring no reference to the theory. Application is made to a complete numerical example. The matter of identifying possible types of flutter in an airplane and of determining the parameters is briefly discussed. A section treating the subject of forced vibrations of a wing in an air stream and the question of air damping in its relation to flutter is included. *Report No. 685, 1940.* For sale by the Superintendent of Documents, Washington, D.C., $0.15.

A Simplified Theoretical Method of Determining the Characteristics of a Lifting Rotor in Forward Flight. F. J. Bailey, Jr. Theoretically derived expressions for the flapping, the thrust, the torque, and the profile drag-lift ratio of a nonfeathering rotor with hinged, rectangular, linearly twisted blades are given as simple functions of the inflow velocity and the blade pitch. Representative values of the coefficients of each of the terms in these expressions are tabulated for a series of specified values of the tip-speed ratio. Analysis indicates that the tabulated values can be used to calculate, with reasonable accuracy, the characteristics of any rotor of conventional design.

In order to demonstrate the method of using the tables included with the analysis, the characteristics of a typical autorotating rotor are calculated. A convenient method is devised for expressing, by means of a single chart, the relationship between the drag and the lift characteristics of the rotor for various combinations of pitch-tip-speed ratio, and solidity.

The decelerating torque and the profile-drag-lift ratio of the rotor are evaluated on the assumption that the profile-drag coefficient of a blade element can be expressed as a function of the angle of attack of the element by the first three terms of a power series. A convenient method is developed for determining appropriate values of the coefficients of the different powers of the angle of attack in this series for conventional airfoil sections at any Reynolds Number.

When the blade elements reach angles of attack above a certain limiting value, the drag coefficient begins to exceed the value given by the series. For certain limiting conditions of pitch and tip-speed ratio, where the elements begin to reach high angles while moving at high velocity, the rotor performance is impaired and the theory becomes optimistic. A method of determining these limiting conditions is developed.

A further limitation, imposed by the requirement that compressibility shock be avoided at the advancing blade tip, is found to limit high-speed flight to high tip-speed ratios, where the autorotating rotor is inherently inefficient. *Report No. 716, 1941.*

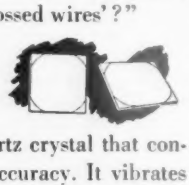
Determination of Control-Surface Characteristics from NACA Plain-Flap and Tab Data. Milton B. Ames, Jr., and Richard I. Sears. The data from previous N.A.C.A. pressure-distribution investigations of plain flaps and tabs with sealed gaps have been analyzed and are presented in this paper in a form readily applicable to the problems of control-surface design. The experimentally determined variation of aerodynamic parameters with flap chord and tab chord are given in chart form and comparisons are made with the theory. With the aid of these charts and the theoretic relationships for a thin airfoil, the aerodynamic characteristics for control surfaces of any plan form

Stainless "jewels" Make RADIOS Tick!

"FLIGHT SQUADRON 5 PROCEED . . ."

While a Navy radioman booms orders, life-or-death instructions to frontline fighters are going out from scores of other Army and Navy transmitters in the same area. The question is, "What prevents 'crossed wires'?"

STAINLESS ELECTRODES



The heart of it all is a tissue-thin quartz crystal that controls radio frequencies to pin-point accuracy. It vibrates inside the electrodes. In many transmitters and receivers these electrodes are made of ARMCO Stainless Steels.

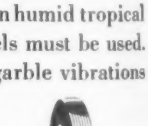
The rustless "housing" for the crystal is a marvel of precision. This electrode is 3/4-inch square and less than 1/16-inch thick. During fabricating an extremely shallow flat depression is forced into the center of the electrode by a circular punch which covers all but the four corners. This leaves little "feet" on the corners, which are given an optical grind—often until they are only .0002-inch high!

THEY WORK "FEET FIRST"

Next a crystal is placed between two ARMCO Stainless Steel electrodes, with the "feet" facing each other. Then the edges are sealed. The hairline air-gap inside is just enough to permit vibration of the crystal — *on an unvarying frequency*.

There are many reasons why ARMCO Stainless is used for the electrodes. In salty atmosphere or in humid tropical areas these highly corrosion-resisting steels must be used. Rust or dirt inside the electrodes would garble vibrations —halt all communication.

OPTICAL DEAD-FLAT



Then, too, the steel must be smooth-surfaced and polished to what is known as optical dead-flat. Obviously, too, it must be non-magnetic.

If this precision equipment suggests new uses for ARMCO Stainless Steels in your future products, get in touch with us. We'll be glad to give you complete information. Just address The American Rolling Mill Co., 2651 Curtis St., Middletown, Ohio.

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THE AMERICAN ROLLING MILL COMPANY

with plain flaps and tabs with sealed gaps may be determined. A discussion of the basic equations of the thin-airfoil theory and the development of a number of additional equations that will be helpful in tail design are presented in the appendixes. The procedure for applying the data is described and a sample problem of horizontal tail design is included.

The data presented and the method of application set forth in this report should provide a reasonably accurate and satisfactory means of computing the aerodynamic characteristics of control surfaces. *Report No. 721, 1941.*

High-Speed Tests of a Model Twin-Engine Low-Wing Transport Airplane. John V. Becker and Lloyd H. Leonard. Force tests were made of a one-eighth-scale model of a twin-engined low-wing transport airplane in the N.A.C.A. 8-ft. high-speed tunnel to investigate compressibility and interference effects at speeds up to 450 m.p.h. In addition to tests of the standard arrangement of the model, tests were made with several modifications designed to reduce the drag and to increase the critical speed.

The results show serious increases in drag at critical Mach Numbers ranging from about 0.47 to 0.60 attributable to the occurrence of compressibility burbles on the standard radial-engine cowlings, on sections of the wing as a result of wing-nacelle interference, and on the semiretracted main landing wheels. The critical speed at which the shock occurred on the standard cowlings was 20 m.p.h. lower in the presence of the fuselage than in the presence of only the wing. The drag of the complete model was reduced 25 per cent at 200 m.p.h. by completely retracting the landing gear, fairing the windshield irregularities, and substituting streamline nacelles (with allowance made for the proper amount of cooling-airflow) for the standard nacelle arrangement. The values of the critical Mach Number were considerably increased as a result of the mentioned improvements. *Report No. 750, 1942.*

The Mean Aerodynamic Chord and the Aerodynamic Center of a Tapered Wing. Walter S. Diehl. A preliminary study of pitching-moment data on tapered wings indicated that excellent agreement with test data was obtained by locating the quarter-chord point of the average chord on the average quarter-chord point of the semispan. The study was therefore extended to include most of the available data on tapered-wing models tested by the N.A.C.A.

The final comparisons were made on the basis of the differences between the location of the aerodynamic center as determined by calculation and by test. The agreement obtained when the mean quarter-chord point was located by geometry alone was appreciably better than that obtained by introducing aerodynamic corrections. Since the wing models included extreme conditions of taper, sweepback, and twist, it is evident that the calculations required to determine the mean aerodynamic chord may be greatly simplified and at the same time give improved accuracy. *Report No. 751, 1942.*

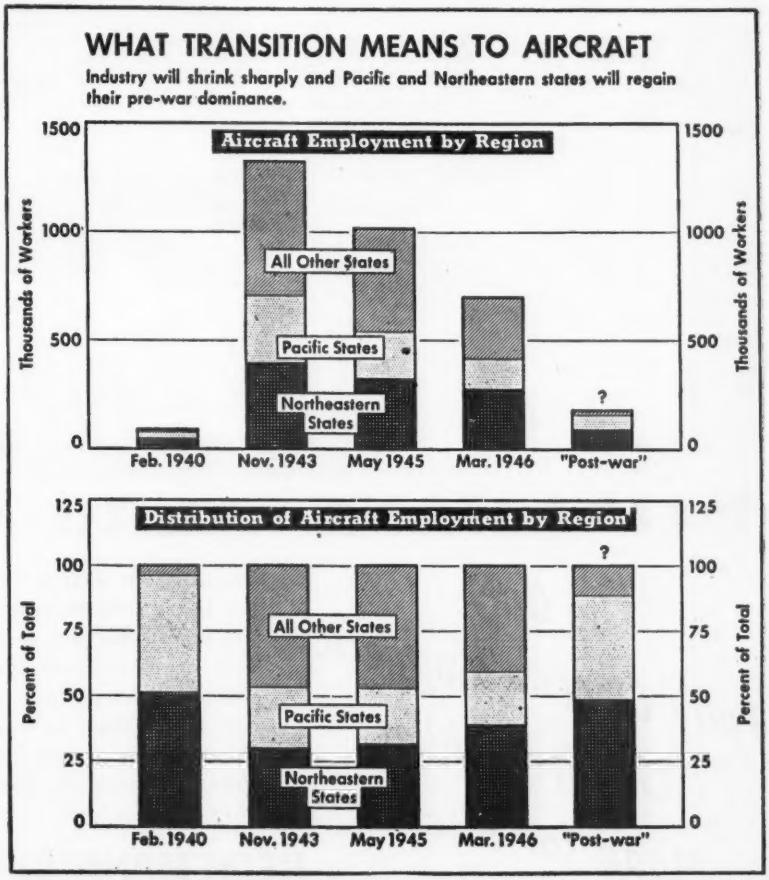
Navy Department

Basic Electricity. This is a basic reference book for those enlisted men of the Navy whose duties require them to have a knowledge of the fundamentals of electricity. Information is given about the electrical constituents of matter, static electricity, electricity in motion, electrical circuits, and electrical equipment. Important electrical laws are explained. The closing chapters discuss vacuum tubes, transformers, and electrical measuring equipment. *Navpers 10662,* Bureau of Naval Personnel.

Flight Thru Instruments. With multicolored illustrations, diagrams, tables, graphs, charts, and cutaway photographs, an instruction manual gives fundamental information about the theories of aeronautics and the operation of naval aircraft, with particular reference to the instruments and their functions. The main chapters show how vision is attained at ranges greater than human sight, give detailed descriptions of the various flight instruments, and instructions for the performance of combat maneuvers. Appendixes contain explanations of specific flight instruments, including the gyroscope and instruments activated by it, the atmosphere and instruments activated by pressure, remote-indicating compasses, and other instruments. Other instructions are given in the appendixes for reporting instrument trouble, flight-training patterns, and a basic refresher course. *NAVAER 00-80W-7,* issued by the Aviation Training Division, Office of the Chief of Naval Operations.

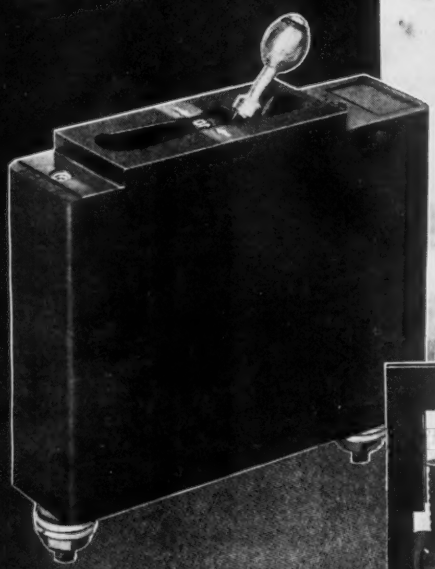
Office of War Mobilization and Reconversion

The Road to Tokyo and Beyond is the title of the third report by the Director of War Mobilization and Reconversion to the President, Senate, and House of Representatives. It is dated Ju y 1, 1945, and takes up problems following the end of the hostilities in Europe. Its principal sections discuss the needs of the armed forces for finishing the war with Japan, the problems of reconversion, the disposition of surpluses, and economic stabilization



This illustration, taken from *The Road to Tokyo and Beyond,* indicates the probable postwar utilization of the existing airplane building capacity. It is estimated that at the most 10 per cent of the existing capacity and even a smaller portion of the new plants in the interior of the United States will be used to produce aircraft for peacetime markets.

It's Up To You To Bring 'Em Back Alive



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Other topics deal with food questions, aid to liberated Europe, the meaning of the day of victory over Japan, and the bridge between the present and the immediate future. The operations of the Advisory Board are reviewed and reference is made to the survey of war agencies undertaken with a view toward reorganization of certain Government departments. The text is supplemented by numerous charts.

U.S. Office of Education

Visual Aids Unit Instructor's Manuals. A series of illustrated booklets constituting a part of a system of instructional aids prepared for the training of aircraft workers. The system includes motion-picture films and film strips, as well as the manuals for the use of the instructors. The manuals give suggestions for the preparation of materials and the use of the visual aids provided for the course of instruction.

"Aircraft Work Series" includes the following manuals: *Control Cables No. 2*, Making a Five Tuck Splice; *Control Cables No. 3*, Swaging Cable Terminals. A series on *Aircraft Maintenance* incorporates booklets on Patching Fabric, U.S.O.E. Unit 250; Repairing Structural Tubing, U.S.O.E. Unit 253; Adjustments After Check Flight, U.S.O.E. Unit 261. The *Preventive Maintenance* series contains a booklet on Preflight Inspection—Engine, U.S.O.E. Unit 281, and Periodic Inspection—Airplane, U.S.O.E. Unit 282. A separate instructor's manual is titled *Assembling and Riveting No. 3*: Drilling with Portable Drill Motors. U.S. Office of Education, Division of Visual Aids for War Training.

U.S. Senate

Wartime Technological Developments. A monograph contains a study made for the Subcommittee on War Mobilization of the Committee of Military Affairs of the U.S. Senate. It is limited to published information concerning the scientific and technical advances resulting from the war effort of the nation, from which benefits are expected to accrue in the postwar period. It represents the first effort to compile and digest information with regard to hundreds of scientific achievements and is intended to provide a guide for Congress and for public and private agencies and persons engaged in formulating postwar programs.

One section of the report deals with aviation, with particular regard to air frames, engines, propellers, gliders, and general information. *U.S. Senate, Subcommittee Monograph No. 2*, May, 1945, $0.50.

War Department

Administrative Audit Procedures for Cost-Plus-A-Fixed-Fee Supply Contracts. This manual is issued in loose-leaf form and is revised periodically as new pages may be required. Following an introductory section containing general information about the purpose and use of the manual, the chapters contain a review and appraisal of the contractor's procedures; the application of selective audit procedures; audit procedures for completed cost-plus-a-fixed-fee supply contracts; audit procedures for terminated contracts of a similar nature; and cost interpretations. *War Department Technical Manual TM14-1000*, May, 1945. For sale by the Superintendent of Documents, Washington, D.C., $0.25.

War Production Board

War Production in 1944. The report of the Chairman of the War Production Board for the calendar year 1944 gives a review of the operations of that Government agency. Following an introduction that is composed of brief statements of the tasks undertaken by the Board, the main sections of the report deal with the production record in 1944; problems of supplying key resources in the form of facilities, materials, components, and man power; controlling the flow of resources into production; civilian requirements and reconversion planning; organization and management. An appendix includes a chronology of the War Production Board in 1944 and statistical data for the charts included in the report. For sale by the Superintendent of Documents, Washington, D.C., $0.25.

War and Navy Departments

Army-Navy Contractors Guide. Suggestions are given in a booklet of 59 pages for the benefit of war contractors with regard to systems of terminated fixed-price supply contracts with the Army and Navy. It gives a chronologic picture of the war contractor's course of action from the time his contract is terminated to the final settlement. It also presents a sequence of steps which the contractor can take before termination, with regard to the policy of Advanced Planning and Pre-Termination of Agreements. Specimen forms are reproduced and filled in with hypothetic data, to assist the contractor in using these forms. The guide is not offered as a substitute for the Joint Termination Regulation but is intended to help in the interpretation of the regulations. *War Department Pamphlet No. 34-2* and *Navy Department NAVEXOS P-77*, May, 1945.

Joint Termination Regulation, Revision No. 1. A comprehensive revision, of the regulations concerning termination of certain war contracts has been prepared under the joint authority of the War and Navy Departments. For the War Department this is a complete revision of War Department Procurement Regulation 15 (Procurement Regulation Revision 47, dated April 20, 1945). For the Navy Department this revision No. 1 has been issued pursuant to the Secretary of the Navy Directive of October 25, 1944, as amended.

To facilitate comparison between the Regulation as issued and the current revision, all amendments are grouped in a section-by-section analysis under the headings of (a) major changes; (b) less important changes; and (c) formal changes. In addition to the explanatory first section, the other sections refer to Procedures for Terminating Prime Contracts; Interim Financing; Termination Inventory; General Basis for System; Settlements of Subcontract Claims; Settlement of Prime Contract Claims; Special Procedures and Reports; Forms and Instructions. Appendixes include revisions of the Joint Termination Accounting Manual; the Contract Settlement Act of 1944 and Regulations of the Office of Contract Settlement; and Regulations of other Government agencies. *Revision No. 1, 20 April 1945, Readjustment Distribution Center*, New York.

British Information Services

The Relation Between Illumination and Visual Efficiency—The Effect of Brightness Contrast. H. C. Weston. This report is the second of a series dealing with the effect of characteristics such as size, contrast, and brightness on the facility with which these objects can be seen. It describes investigations to ascertain a relationship between these characteristics for satisfactory visibility, so that the illumination suitable for the performance of industrial or other tasks may be computed.

The present report deals with the relationship between illumination and another variant of visual tasks, namely, the contrast of brightness which differentiates details of the task object, or the object and its background. After an introduction giving definitions of the terms and other explanations, the two investigations are reported in detail and the conclusions are set forth. Two appendixes explain certain mathematical formulas used. *Report No. 87, Medical Research Council, British Industrial Health Research Board.* British Information Services, New York, $0.25.

Commonwealth of Australia

The History of Australian Aviation. Peter Hemery. This mimeographed paper traces the development of aeronautics in Australia from the early work of Hargrave through the record flights of Hawker, the Smith brothers, Hinkler, Kingsford Smith, and many others. It follows the experiences of the air lines from the small beginnings of Qantas to the present system of air transport which covers the continent. A short chapter on the work of the Australians in the present war closes the brochure. *Australian News and Information Bureau*, New York.

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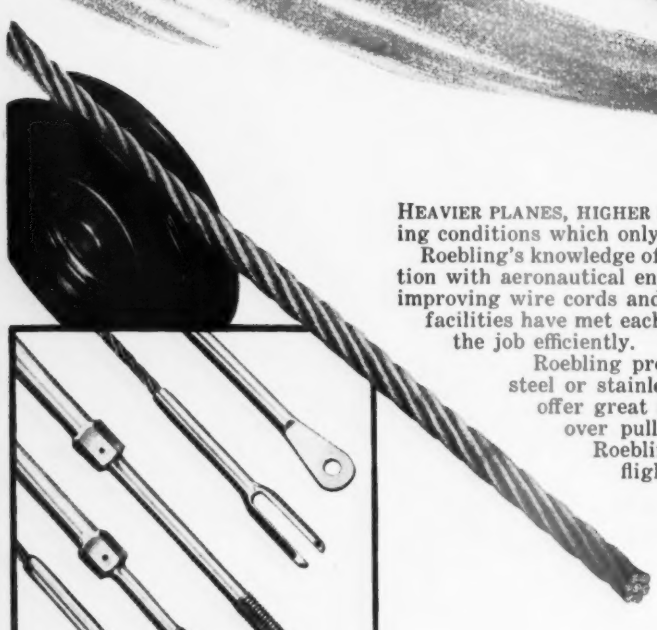

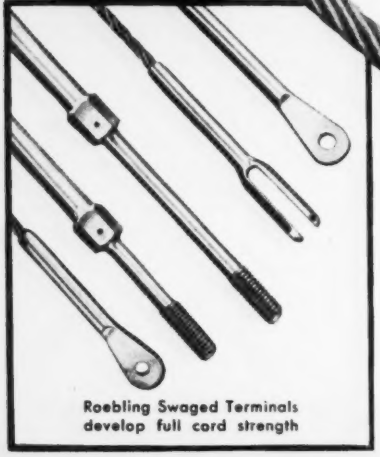

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Hilary St. George Saunders

Contents: Dedication to Flight; Vehicles Lighter Than Air; Birth of the Royal Flying Corps; 1914: The Squadrons Go to France; Air Reconnaissance: A New Element in War; The Royal Naval Air Service at Gallipoli; The Air Arm Gathers Strength; Spirit of Attack: The Somme Battles; Air Power Goes to Sea; 'In That Decorum . . . Perfectly Instructed'; Defensive Offensive: France 1917–1918; The Desert Air: Middle East 1914–1917; Air Defence of Great Britain 1914–1918; R.F.C. + R.N.A.S. = R.A.F.; Fathers of the Fleet Air Arm; Air Power Climbs to the Zenith; Winged Victory; The Clipping of the Wings; 'An Eagle Mewing Her Mighty Youth'.

The history of the Royal Air Force includes more than the development of one service. It embraces naval and military aviation and the interlocking character of strategic and tactical air power. This book traces the beginnings of the use of aircraft for military purposes in England and follows its expansion to 1939. It is hoped to publish later a companion volume that will carry the story on to the end of the present war.

Each chapter of the book is devoted to one phase of the work of the R.A.F. in many areas. Although the history is principally concerned with detailed accounts of World War I, it follows the activities of British airmen in the Middle East, in Africa, and in India.

The appendixes contain a detailed chronology from 1884, a chart showing the organization of the Royal Flying Corps in July, 1916, and other data. Oxford University Press, New York, 1945; 356 pages, $3.75.

The ABC of Flying

Lt. Co . W. Lockwood Marsh

Contents: Lift and Drag; Stability and Control; Engine and Airscrew; Design and Construction.

This book by the Editor of *Aircraft Engineering* explains in simple language, without recourse to mathematics, the principles underlying the flight of airplanes, with some notes on design and production. It is intended primarily for the new student of aeronautics but also serves to give those of all ages the idea of elementary flying.

The book has excellent illustrations comprising 42 line drawings and 37 half-tone plates showing details of design and construction. Among the photographs reproduced are pictures of the flow around an airfoil. The volume is a valued addition to the primary study of aeronautical engineering. Pleiades Books, London, 1945; 88 pages, 6*s*.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N. Y.

Air Law

C. N. Shawcross and K. M. Beaumont, assisted by P. R. E. Browne and A. R. Paterson

Contents: Introduction; Laws Restricting and Regulating the Right to Fly; Carriage by Air; Surface Damage, Collisions and Other Instances of Liab lity from the Operation of Aircraft; Aircraft and Aviation Insurance; Ownership, Possession, Hire, Manufacture and Other Commercial Dealings in Aviation; Airports and Aerodromes; Air Transport Services: Laws Governing Their Establishment and Operation; Law of Master and Servant in Connection with Use and Operation of Aircraft; Jurisdiction in Air Law and Territorial Application of English Legislation.

This book is intended to provide a connected exposition of the principal legal rules governing the flight and operation of aircraft; a résumé of the rules that derive from international law, as well as those derived from the English Common Law and Statutes; and, for persons interested in air transport, a handbook with as complete a collection as possible of all statutes, international conventions, and subsidiary legislation connected with air law.

The authors aimed to attain a high degree of practical utility and to satisfy the practical requirements of the lawyer, the administrator, the legislator, and others interested in the commercial operation of aircraft rather than to provide the logical completeness of an academic treatise.

It approaches the status of a standard work on air law and one that will become of increasing utility as international air law becomes more nearly standardized through the work of new congresses such as that held in Chicago. The book is annotated with thousands of references to cases and reports, so that it is not only helpful in its text but a guide to the broad field of air law. Available from The Carswell Company, Limited, Toronto, 1945; 816 pages, $13.50 in the United States, $15 in Canada.

Government Policy Toward Commercial Aviation

Gilbert Goodman

Contents: The Government's Role in the Establishment of Scheduled Air Transportation; Commercial Aviation in Transition from Insecurity to Security of Investment; Failure of Competition in the Coordination of the Air Routes; Failure of Competition in Reletting the Mail Contracts; Regulation of Mail Rates: Domestic Services; Foreign Air Transportation—Certificates of Convenience and Necessity; Mail Rate Regulation: Foreign Services.

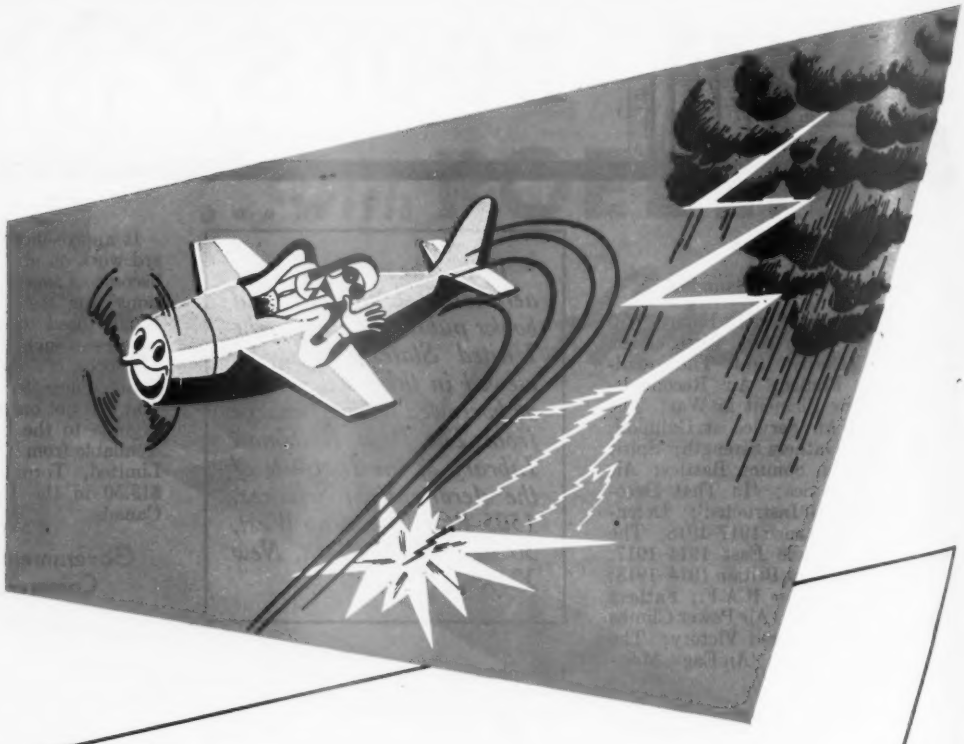
This study of competition and the regulation of rates of the air lines of the United States traces the Government's role in the establishment of scheduled air transportation. It reviews the laws that have been enacted to regulate services and rates. The failure of competition in the coordination of air routes and letting of mail contracts is described. Foreign, as well as domestic, air services are included.

For those who are interested in the legalistic problems of air traffic, the book will provide an excellent summary of the history of this phase of American air transport. King's Crown Press, New York, 1944; 122 pages, $1.60.

Theory and Testing of Jet Propulsion Motors and Rockets

Zygmunt Fonberg

Contents: General Theory of Reaction Propulsion; The Thermodynamics of Reaction Motors; Types of Reaction Motors; The Rocket; Theory of the Compression-Expansion Type of Jet Motor; Theory of the Resonance Type Jet Motor; The Athodyd; Thrust Amplifiers or Boosters; Testing of Jet Motors and Rockets; Testing of Rocket; Testing of Jet Propulsion Motors; Rotating Test Stand; Wind Tunnel; Testing of the Athodyd; Testing of the Resonance Jet Motor.



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This paper on the theory and testing of jet propulsion engines and rockets does not pretend to be an exhaustive treatise. It is an attempt to present simply the fundamental thought in the field of reaction engines.

Illustrative examples show the practical application of the formulas and definitions to the solution of problems in connection with rockets and jet propulsion engines. The essential thermodynamic considerations also are included. Though the use of calculus has been avoided in this paper, the final results of such computations are given whenever necessary. Aircraft Jet and Rocket Corporation, New York, 1945; 82 pages, $2.00.

Handbook on Designing for Quantity Production

Prepared and Edited by Herbert Chase

Contents: Design of Die Castings; Design of Sand Castings for Quantity Production; Design of Screw-Machine Products; Design of Stampings; Design of Die-Forged Parts for Quantity Production; Notes on and Accomplishments in Hot Heading; Notes on the Design of Cold-Headed Parts; Design of Plastic Moldings for Economical Quantity Production; Die Cast or Sand Cast?; Permanent-Mold and Die Castings Compared; Which Type of Nonferrous Casting?; Die Cast or Stamped?; Die-Cast or Screw-Machine Products?; Cold-Headed or Screw-Machine Products?; Die Castings and Plastic Moldings Compared.

Written particularly for engineers and engineering students, this text contains information about the designing of metal and plastic parts for quantity production. Many of the chapters have been written by specialists in the respective subjects discussed. Particulars are given about which methods should be used and which should be avoided in designing items for efficient quantity production. Specific rules for design are given in the seven chapters constituting Part I. In Part II, various types of products manufactured in quantities at a moderate or minimum cost are compared, one against the other, to aid the designer in choosing the type of design best adapted for economical manufacture in particular instances. McGraw-Hill Book Company, Inc., New York, 1944; 517 pages, $5.00.

Aluminum

Nathaniel H. Engle, Homer E. Gregory, and Robert Mossé

Contents: Factors of Aluminum Production; The Aluminum Industrial Structure; Aluminum Markets; Recommendations for Public Policy.

In this analysis the authors attempt to portray the aluminum industry as it will be when the war ends, in the belief that such an appraisal will be a guide to businessmen and Government officials in deciding future policies. To facilitate the analysis, a limited amount of historical background is included. The technical and economic aspects of the aluminum industry are presented, although not from the standpoint of the specialist in either field. Important economic considerations are discussed. Richard D. Irwin, Inc., Chicago, 1945; 494 pages, $6.00.

Questions and Answers for Airplane and Engine Mechanics

Compiled and Edited by Aviation Research Associates in cooperation with the technical staffs of the Academy of Aeronautics and The Casey Jones School of Aeronautics

Contents: Aircraft Metal Repairs; Aircraft Alignment and Assembly; Fabric and Doping; Brakes and Shock Absorbers; Hydraulic Systems; Civil Air Regulations; Engine Overhaul and Maintenance; Ignition Systems; Engine Starters; Generators; Electrical Systems; Fuel Systems; Lubrication Systems; Aircraft Instruments.

Practical and theoretic knowledge required by airplane mechanics is presented in the form of 3,300 questions and answers. Subjects dealt with include metalworking and welding; fabric and doping; rigging and alignment; hydraulics and hydraulic systems; engine carburetion, fuel, and induction systems; propellers; engine overhaul and maintenance. Civil air regulations are also included in separate chapters concerning certificates, instruments and equipment, repairs, and propellers.

The book is written primarily for the student or apprentice, as a check and review of his knowledge before taking an examination for a C.A.A. certificate, but it is also intended as a refresher for experienced mechanics and to bring their information up to date. It is also offered for use to test and evaluate any course of instruction or textbook by means of direct comparison. The subject matter is divided into 61 groups for ease of reference and to facilitate selection of material by the student or the instructor. McGraw-Hill Book Company, Inc., New York, 1944; 502 pages, $4.00.

SAE Handbook, 1945 Edition

Contents: New and Revised Standards: Electrical Equipment; Gasoline Engine; Iron and Steel; Lighting; Non-Ferrous Metals; Non-Metallic Materials; Parts and Fittings. Corrections: Ball and Roller Bearings; Non-Ferrous Metals; Screw Threads; Tractor Equipment; Parts and Fittings. Cancellations: Aeronautical; Electrical Equipment; Lighting.

The current edition of this handbook contains standards and other data arranged in ten sections, each section beginning with a title page giving a list of pages in that section. The "skip" system of page numbering is used, to allow for expansion in future editions and to retain the same page numbers for as many as possible of the individual standards in succeeding editions. The first section includes the aeronautical parts, materials, and codes.

New and revised standards are given as indicated in the contents, followed by corrections for existing items and cancellations. Society of Automotive Engineers, Inc., New York, 1945; $5.00.

Book Notes

The Canadian Aircraft Industry; Air Industries and Transport Association of Canada, Ottawa, Canada.

This loose-leaf handbook, issued by the Air Industries and Transport Association of Canada, gives the salient facts of the development of the manufacture and use of aircraft in Canada from 1914. Each company is treated individually and statistically. There is also much general information about expenditures in the Dominion and the legislative and governmental action affecting the placing of orders from 1937 through 1940. A summary gives the present status of the industry, figures for production up to the end of 1944, and estimates for 1945.

Power in the Pacific, compiled by Capt. Edward Steichen; U.S. Camera Publishing Corporation, New York, 1945; 144 pages, $2.00.

These exceptionally fine action pictures were taken under the supervision of Capt. Edward Steichen, officer in charge of naval aviation photography. They give a dramatic picture story of air warfare against the Japanese forces in the Pacific combat area.

The 150 official U.S. Navy, Coast Guard, and Marine Corps photographs selected for this book portray the life and fighting activities of airmen aboard carriers and during invasions. They are accompanied by text which describes each incident with vivid comments.

Survey of American Listed Corporations; Data on Profits and Operations, 1942–1943, Part II; U.S. Securities and Exchange Commission, Philadelphia, October, 1944; 215 pages.

This report, issued by the Securities and Exchange Commission, gives data on profits and operations for the years 1942 and 1943 of industrial corporations that have securities listed and registered under the Securities Exchange Act of 1934 or file annual reports under the Securities Act of 1933. It is issued in five parts; Part II of which contains the statements of 32 aircraft and aircraft-equipment manufacturing com-

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panies. In Part V, 14 air transport companies are listed.

Among the tabulated data shown are: net sales, operating profit, provision for war and related contingencies; net profit before and after income taxes; selling, general, and administrative expenses; maintenance and repairs, depreciation, depletion, amortization; intangible assets, net worth; net profit before income taxes as a percentage of net worth; and net profit after income taxes as a percentage of net worth. It does not give the percentage of profit with respect to net sales. Numerous explanatory notes accompany the tables.

Practical Marksmanship, by M. M. Johnson, Jr.; William Morrow and Company, New York, 1945; 183 pages, $2.50.

This book gives advice on the use of guns and how to improve marksmanship. It should be helpful to aircraft gunners, combat soldiers, and sportsmen. It is written by an expert and begins where the military manuals leave off.

Insignia and Decorations of the U.S. Armed Forces, by Gilbert Grosvenor, J. R. Hildebrand, Arthur E. DuBois, Gerard Hubbard, Elizabeth W. King, La Verne Bradley, Robert D. Ewin, etc.; National Geographic Society, Washington, D.C., 1945; 208 pages, $1.00.

The insignia used by the armed forces of the United States have multiplied so greatly that this new edition of this valuable guidebook will be extremely serviceable in assisting in the recognition of badges and decorations worn by officers and enlisted personnel. In the first edition there were 1,701 color reproductions; this edition contains 2,476, an indication of the increased use of decorative insignia.

The text, written by authorities on special uses of insignia, gives a complete description of the medals, patches, badges, devices, and ribbons authorized for use at present.

One of the interesting sections shows the changes in aviation insignia since the original "Military Aviator" badge was authorized on May 27, 1913.

Old Leatherface of the Flying Tigers, by Keith Ayling; The Bobbs-Merrill Company, New York, 1945; 274 pages, $2.50.

The story of the life of General Chennault is unique among those of all air officers. His determination to become a pilot, his radical tactical theories, and his great career as Commander of the Chinese Air Forces make his biography one that has all the elements of the history of a modern knight of the skies.

This book traces his life from its humble origin to his rank as one of the great leaders in the present war. His work for China marks an outstanding achievement in the record of international comity.

Principles of Firearms, by Charles E. Balleisen; John Wiley and Sons, Inc., New York, 1945; 146 pages, $2.50.

This textbook on guns is for the use of engineers and those requiring an up-to-date guide on engineering fundamentals essential for the analysis, design, and construction of modern firearms.

Twenty Careers of Tomorrow, by Darrell and Frances Huff; Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1945; 281 pages, $2.50.

At a time when so many young men are considering the kind of job they wish to secure, this book will serve as a helpful guide. It tells of the possibilities in various industries and the kind of work that will be available.

The chapter on employment possibilities in the aircraft industry is stimulating and should be an incentive to many young men to enter this field for their future career.

Bamboo to Bombers, by Stanley Washburn, Jr.; Albert Whitman & Company, Chicago, 1945; 84 pages, $1.25.

This revised edition gives in text and pictures a history of famous aircraft. Illustrated by striking drawings, it traces man's conquest of the air from da Vinci to the present. Although it is in no sense a juvenile work, it is the type of book that also makes an interesting gift for young folks.

Rocket Research, by Constantin Paul Lent; The Pen-Ink Publishing Company, New York, 1945; 99 pages, $5.00.

New material has been added to the second edition of this handbook on the principles of modern rocketry and the history of rocket developments. The author tells about early rocket designs and experiments. Information is given about rocket propellants, applications, and tests. The rockets used by the Allied and enemy armies are described. New illustrations of rockets and hot-air jet designs are included.

Elementary Meteorology, by Vernor C. Finch, Glenn T. Trewartha, M. H. Shearer, and Frederick L. Caudle; McGraw-Hill Book Company, Inc., New York, 1942; 301 pages, $1.32.

This text on elementary meteorology has been prepared especially for use in military preflight training courses, but is also suitable for students who plan to enter the aviation industry after the war. Information is given about the earth, and its planetary relations, the atmosphere, storms, and climates. Weather applications to aviation are discussed in the concluding chapter.

Lathe Operations, by Lewis E. King; The Macmillan Company, New York, 1944; 119 pages, $1.75.

Milling Machine Operations, by Lewis E. King; The Macmillan Company, New York, 1944; 123 pages, $1.75.

Essential information for performing various lathe operations is given in the first of these two volumes on machine-shop operations. The second volume is designed to help the student learn to perform various milling-machine operations. In both books the technical information is organized so that it may be studied in a shop-theory class or while the student is performing the operation.

The New Plastics, by Herbert R. Simonds and M. H. Bigelow, assisted by Joseph V. Sherman; D. Van Nostrand Company, Inc., New York, 1945; 320 pages, $4.50.

In this book the author has brought together information about the important plastic materials developed since 1940. Important advances made throughout the plastic industry are reviewed. Particulars are given about the composition, methods of manufacture, and the properties and uses of the new plastics, including those that have already reached tonnage production and those that are closer to the pioneer stage.

Chapters are given to established new materials, improvements in materials, new fibers, adhesives, laminating materials, new applications of wood and paper. Synthetic rubbers, new processes, new forms and coatings, and plastics trends are discussed in other chapters. Chemical diagrams of some of the more important new plastics are given in an appendix.

Wings and the Weather, by A. L. Chapman, Raymond Fletcher, and C. C. Maxey; Pitman Publishing Corporation, New York, 1945; 188 pages, $1.50.

This study guide in meteorology for pilots has been written as an aid to both students and instructors in the intensive courses in aeronautical meteorology which are now being offered. The subject is presented in the form of a series of discussion questions that are designed to develop mastery of the subject matter in a logical sequence.

Synthetic Rubber from Alcohol, by Anselm Talalay and Michel Magat; Interscience Publishers, Inc., New York, 1945; 298 pages, $5.00.

This survey, which is based on Russian publications, deals with processes of manufacturing synthetic rubber from alcohol. Chapters are devoted to the Lebedev process, the technology of the S.K. process, polymerization, and the physiochemical properties of the polymer.

Metallography and Heat-Treatment of Steel, Volume III, by Ernest J. Teichert; McGraw-Hill Book Company, Inc., New York, 1944; 577 pages, $5.00.

This is the third of three volumes by the author, which comprise a curriculum in ferrous metallurgy. It deals with the physical metallurgy of iron and steel alloys, metallography, and heat-treatment. Published in revised form, it embodies recent findings and practices of the industry and includes a search of published matter on the subject. The book is one of The Pennsylvania State College Mineral Industries series.

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Treatise on Thermodynamics, by Max Planck, translated with the author's sanction by Alexander Ogg; Dover Publications, New York, 1945; 297 pages, $2.75.

This is a translation from the seventh German edition of the author's treatise on thermodynamics. The book encompasses fundamental facts, definitions, principles of thermodynamics, and applications to special states of equilibrium.

German-English Dictionary of Metallurgy, by T. E. R. Singer; McGraw-Hill Book Company, Inc., New York, 1945; 298 pages, $4.00.

This German-English dictionary is devoted to terms used in metallurgy and related subjects, including mining, mineralogy, and metalworking. In compiling it the author has given special attention to the modern German tendency to eliminate from the German language technical words of nonGerman origin. In such cases both the present-day and the more familiar German words are given.

Introduction to the Mathematical Theory of the Conduction of Heat in Solids, by H. S. Carslaw; Dover Publications, New York, 1945; 268 pages, $3.50.

This is the second edition of a volume on the mathematical methods used in connection with problems of heat conduction in solids. It has been rewritten and enlarged and now includes a discussion of all the important boundary problems associated with the equation of conduction.

Fundamentals of Thermodynamics, by Arthur Stanton Adams and George Dewey Hilding; Harper & Brothers, New York, 1945; 289 pages, $3.75.

This is a revised edition of a book written with the object of providing the beginning student with an understanding of the fundamentals of thermodynamics which will be adequate for further related study in mechanical engineering, physics, and chemistry. The final chapters of the book deal with the thermodynamics of the internal-combustion engine, steam cycles, steam engines and turbines.

Ultra-High-Frequency Radio Engineering, by W. L. Emery; The Macmillan Company, New York, 1944; 295 pages, $3.25.

Written for senior electrical engineering students, this book is devoted entirely to the subject of ultra-high-frequency radio. While the scope has been confined to basic principles, in planning this text the author has endeavored to help the student by correlating theory with practice. The problems that are included are of the type that involve the design of circuits and the predication of their performance. The results of these problems are checked in experiments that are associated with them. Emphasis has been placed on the discussion of the component parts of ultra-high-frequency systems, rather than on the systems themselves, because the latter are readily broken down into their components.

Plane Model Winners, Book No. 1; Model Craftsman Publishing Corporation, Ramsey, N.J., 1945; 48 pages, $1.00.

The first of two booklets devoted to the building of model airplanes has been issued. It contains construction data and drawings for building twelve types of model planes.

Basic Mathematics for War and Industry, by Paul H. Daus, John M. Gleason, and William M. Whyburn; The Macmillan Company, New York, 1944; 277 pages, $2.00.

In writing this book the authors' purpose has been to provide a single text in which the selected principles of elementary mathematics are presented. Subjects include arithmetic, algebra, trigonometry, and geometry. The text should be suitable for courses offered under the Engineering, Science, and Management War Training Program.

Tratado de Combustion Interna y Instrumentos de Aviacion (A Treatise on Internal Combustion Engines and Aircraft Instruments), by Hugo Fuentes F.; Imprenta de la Fuerza Aerea de Chile, Santiago, Chile, 1944; 174 pages, 65 pesos.

According to the author, this book is a compilation of translated excerpts of articles and books published outside Chile about internal-combustion engines and aircraft instruments. His object is to make aviators acquainted with these subjects, especially the members of the Air Force. He believes that everybody connected with aviation should know all there is to know about aircraft engines and instruments in order to make flying as safe as possible.

Topografía (Topography), by Major Alberto Marin Madrid; Instituto Geográfico Militar, Santiago, Chile, 1943; 373 pages.

The author is an officer in the Chilean army and the subject of this study is primarily the application of topography to military tactics. It deals with the various surveying practices by means of modern instruments.

Korrosionstabellen Metallischer Werkstoffe (Corrosion Tables of Metallic Materials), by Franz Ritter; Verlag von Julius Springer, Wien, 1937; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1943; 192 pages, $5.00.

The purpose of this book is to answer the following questions: Which materials may be used for appliances that are exposed to a certain chemical? What is the endurance property of each material under the effect of this chemical, at various temperatures and pressures? In order to answer these questions according to actual research results, the materials are systematically arranged in tables.

The main sections of the book are as follows: Directions for the Use of Tables; Index of Materials; Corrosion Tables; Possibilities for the Use of Substitute Materials; Nomogram to Determine the Corrosion Number.

Die Differentialgleichungen der Technik und Physik (Differential Equations of Technology and Physics), by Wilhelm Hort and Alfred Thoma; Johann Ambrosius Barth Verlag, Leipzig, 1939; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1945; 684 pages, $12.

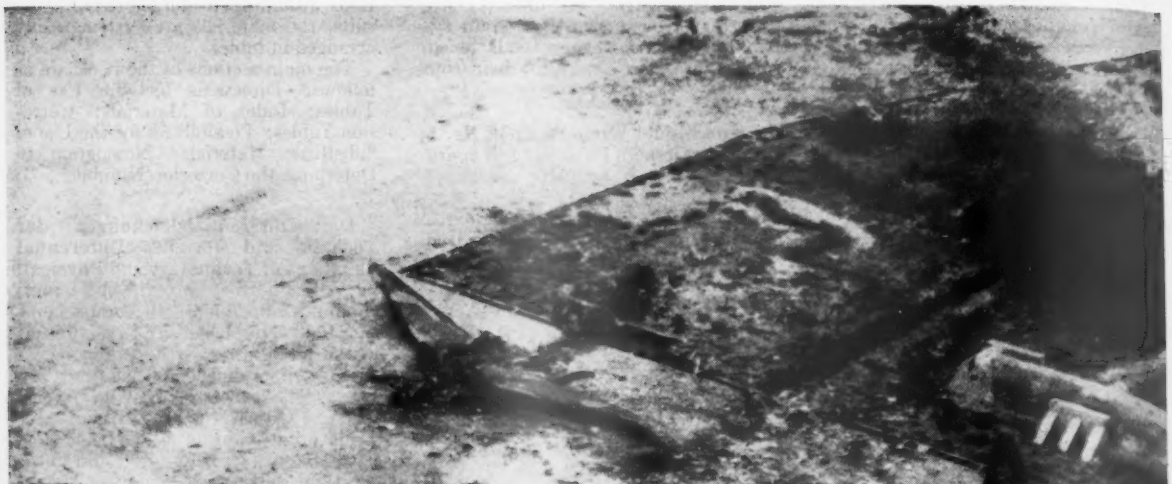
The original author of this book, Professor Hort, died before he could finish the third edition, so Professor Thoma took up the task of concluding it. The book is divided into eight parts. The first part deals with the elements of differential and integral calculus. These elements are arranged systematically and are presented in a more detailed manner than in previous editions. There is also a description of instruments for mechanical integration. The second part, which treats ordinary differential equations, has been arranged in such a way that a correlated group of these equations is systematically investigated from a theoretic point of view. A selection of technical or physical examples in reference to each of these groups explains the previously presented methods.

The third part contains the treatment of numerical and graphic approximation methods, as applied to differential equations of the first order. Approximation methods for differential equations of the higher orders are only briefly mentioned and for these reference is made to the numerous textbooks. The fourth part, on mechanical integration of ordinary differential equations, and the fifth part, giving a summary of differential equations, conclude the first half of the book.

The sixth part, which is of a more theoretic character, presents the various operations that may be carried out with partial differential equations of mathematical physics. Chapters 1, 2, 3, and 5 of this part have been supplemented, while chapters 4 and 6 have been completely revised. Parts 7 and 8 deal with variation calculation and integral equations, respectively.

Belastungsglieder (Load Factors), by Adolf Kleinlogel; Verlag von Wilhelm Ernst & Sohn, Berlin, 1942; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 115 pages, $4.00.

This is a book of formulas and numerical tables for transverse forces, moments, and load factors of a bar that is supported at both ends. It serves as a reference book for the calculation of frameworks and continuous struts.



Destroyed Jap planes litter the runway at Tinian as a result of some "calling cards" left by Navy Liberators. *Official U. S. Navy photograph.*

What happens when a Navy Liberator pays a visit to a Jap airfield? This photograph gives you a rough idea. Bombing, strafing, reconnaissance work — these big Consolidated Liberators and the keen-eyed men who handle them have stacked up an enviable record in the Pacific area.

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Spezifische Waerme, Enthalpie, Entropie, und Dissoziation Technischer Gase (Specific Heat, Enthalpy, Entropy, and Dissociation of Technical Gases), by E. Justi; Verlag von Julius Springer, Berlin, 1938; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1944; 157 pages, $5.90.

The idea that led to the writing of this book grew out of the numerous requests of engineers with reference to the statistical-spectroscopic determination of the specific heat of gases, their enthalpy and entropy, applicable to the Mollier diagrams. The author states that the tables presented in this book will not have the disadvantage of becoming obsolete too soon, as was the case with certain previous numerical tables. The problem of representation has been made difficult by the fact that such heterogeneous branches of science as the thermal equation of state, calometric measuring results, statistical methods of thermodynamics, and structure analysis of the spectra of molecules have to be properly represented.

This book is intended primarily for industry, which does not work with ideal gases but with mixtures of materials that often are highly compressed and chemically variable. Therefore the author found it necessary to supply information to fill voids in the scientific material he had compiled. These contributions are contained in the chapters on caloric properties of compressed gases, on the real state of gaseous mixtures, and on dissociation. In addition he has appended notes on the properties of liquefied and solidified gases.

Metalle und Legierungen fuer Hohe Temperaturen: Erster Teil Zunderfeste Legierungen (Metals and Alloys for High Temperatures: First Part Scale-Resisting Alloys), by W. Hessenbruch; Verlag von Julius Springer, Berlin, 1940; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1945; 254 pages, $8.75.

Based on many years of practical experience, the author presents important data on scale-resisting alloys. In order to make this book of interest to the scientist as well as the practical technician, care has been taken to consider scientific principles side by side with practical experiences. A comprehensive presentation is given of the effect on scale resistance of the addition of small quantities of foreign substances.

The principal chapters are: Physical-Chemical Reaction of the Formation of Oxide Layers; Structure of These Layers; Methods to Determine Scale Resistance; Effect of Various Alloy Elements on Scale Resistance and the Most Important Groups of Heat-Resisting Metal Alloys; Effect of the Addition of Small Quantities of Foreign Substances on Heat Resistance; Reaction of Heat-Resisting Metals and Alloys When Under the Effect of Gases and Vapors (Except Air and Oxygen); Special Application of Scale-Resisting Alloys; Effect of the Manufacturing Process on Heat-Resisting Alloys.

Das Versuchs- und Messwesen auf dem Gebeit des Kraftfahrzeugs (Testing and Measuring Methods as Applied to the Automobile), by W. Kamm and C. Schmid; Verlag von Julius Springer, Berlin, 1938; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1943; 312 pages, $13.85.

This book gives the results of the many years of research undertaken by the authors at the Stuttgart Technical Academy in testing engines and measuring the performance and operating characteristics of automobiles. The authors believe that the information developed through their work is of fundamental value, warranting publication even at the risk of not being up to date.

The book is divided into two main parts—the first relating to engine testing and the second to measuring the performance and running characteristics of automobiles. The chapters are as follows: Fuel Testing; Measuring Fuel Consumption of Engines; Measuring the Quantity of Intake Air; Instruments to Observe the Course of Combustion; Instruments to Record Rapidly Changing Phenomena; Determination of Engine Performance and Output; Measuring of Coolants; Measuring of Temperatures; Investigation of Exhaust Gases; Instruments to Measure Torsional Vibrations; Recording Instruments for General Purposes; Control Arrangements; Single-Cylinder Test Engines; Arrangements of Test Stands; Running Performance; Running Characteristics; Stresses on the Structure of the Automobile and on Its Parts.

Anschauliche Geometrie (Visualized Geometry), by D. Hilbert and S. Cohn-Vossen; Verlag von Julius Springer, Berlin, 1932; published and distributed in the public interest by authority of the Alien Property Custodian by Dover Publications, New York, 1944; 314 pages, $3.50.

Instead of treating the abstract aspect of geometry and the various systems of algebraic geometry that have been developed from it, the authors deal with the concrete representation of geometry. In this way they expect to create a greater interest in mathematics among the general public. Formulas are replaced by elementary representative illustrations, which the reader may easily supplement by means of models.

The aim of this book is to increase the enjoyment of mathematics by guiding the reader through its various phases without the necessity for hard study. Each chapter is a complete unit. Because of the complexity of the material, the authors make no claim to perfection.

Raketenflugtechnik (The Technique of Rocket Flight), by Eugen Saenger; Verlag von R. Oldenbourg, Berlin, 1933; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor Mich., 1945; 222 pages, $5.00.

The main purposes of this book are to present the problem of rocket flight in a practical way and to separate it from some of the ideas prevailing at the time the book was written. All treatments of rocket flight are conducted from a technical rather than from a physical point of view. It is noted that only the most basic principles could be discussed within the limited space of this book, since a complete mastery of the subject would require a technical knowledge that could only be acquired after many years of theoretic and practical experience.

Mengenlehre (Theory of Aggregates), by F. Hausdorf; Dover Publications, New York, 1944; 307 pages, $3.50.

An introduction to the theory of mathematical aggregates or sets for the beginner in the subject, as well as for the mathematician whose main interest lies in some other field of mathematics but who has occasional opportunities in his work to use the methods and results of the theory. The subject is presented in such a way as to be useful to a student having a knowledge of the elements of calculus.

In this third edition, the first nine chapters are but slightly changed from the previous edition. The author states that although a complete revision would be desirable in view of the continuous development of the theory of sets, this has been impossible. However, a tenth chapter has been added in an effort to provide at least a partial review of the progress made since the second edition was published.

Ballistik (Ballistics), by Theodor Vahlen; Walter de Gruyter & Company, Berlin, 1942; published and distributed in the public interest by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1945; 267 pages, $7.20.

This book, although entirely theoretic, adheres closely to practical problems. As a novelty it presents "intermediate" ballistics, to take a place between external and internal ballistics, and also considers ballistics in extremely high altitudes, called "cosmic" ballistics. The subjects of conic oscillation and lateral deviation are brought up to date, while a new theory of fire factors is developed.

The author states that, although von Cranz's is the standard German handbook on ballistics, it is distinctly meant for nonmathematicians and avoids mathematical developments. In contrast to von Cranz's work, this book presents the mathematical phase of ballistics because the author holds that mathematics is absolutely necessary for the proper advancement of the science.

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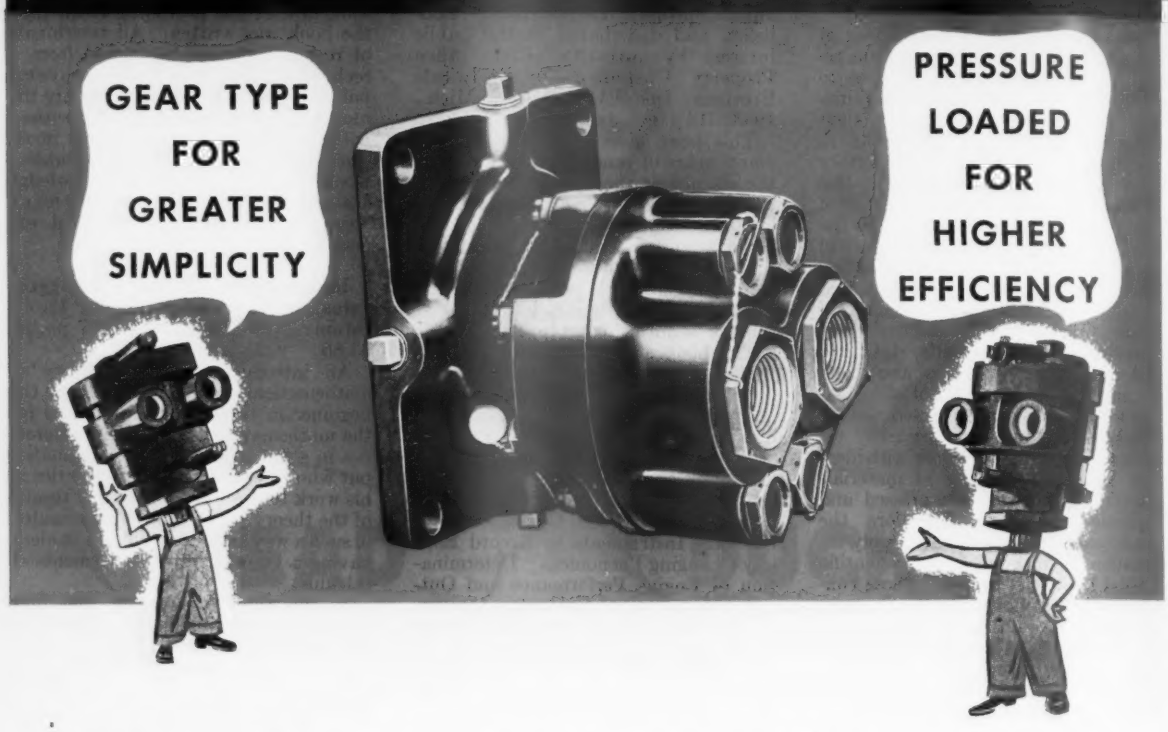

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Reports on Scientific Results of the United States Antarctic Service Expedition, 1939–1941; The American Philosophical Society, Philadelphia, 1945; 398 pages, $4.00.

This volume contains reports on the scientific results of the U.S. Antarctic Service Expedition, 1939–1941. One section is devoted to a report on aircraft activities at West Base, Antarctica. It gives details about unloading and assembling aircraft used by the Expedition, experiences in aircraft operation obtained under the conditions prevailing, and the services rendered by the airplanes. Another section contains detailed reports of weather observations.

An Estimate of the Post War Air Freight Potential from Detroit to San Francisco; The Edward S. Evans Transportation Research, Washington, D.C., 1945; 13 pages.

This is a report of a survey that was made among Detroit manufacturers for the purpose of estimating the reciprocal air haulage of manufactured goods and agricultural products. The survey indicates how much of Detroit's postwar output and what types of goods may be expected to move by air from that industrial area to a seaport. This is intended to give an accurate prediction of the proportionate distribution of postwar freight and suggests the types of manufactured products most likely to be candidates for air travel.

The research also reveals the possibilities offered by air transport in opening and stimulating new markets.

Time Study and Motion Economy for Supervisors, by James D. Shevlin; National Foremen's Institute, Inc., New York, 1945; 73 pages, $2.00.

Written as an aid to the foreman, this book describes how methods of making and handling products can be improved through motion and time study. The procedures are explained with the aid of numerous charts and diagrams.

Surface Finish and Its Measurement, by R. E. Reason; The Institution of Production Engineers, London, 1944; 28 pages.

A reprint of a paper read before the Institution of Production Engineers in October, 1944. After mentioning briefly some of the more recent work in the finishing of surfaces, the writer discusses surface measurement, stressing particularly the true nature of the indications derived from stylus instruments.

Workbook in Elementary Meteorology, by Frederick L. Caudle; McGraw-Hill Book Company, Inc., New York, 1945; 191 pages, $1.24.

In this workbook for students of meteorology, both textual material and exercises in weather have been combined in one volume. Emphasis is placed on applications to aviation. It contains 44 units, arranged in four sections of eleven units each. Test questions are supplied at the end of each section. The book may be used either as a basic text or as a supplement to standard textbooks on the subject.

A Treatise on the Theory of Bessel Functions, by G. N. Watson; The Macmillan Company, New York, 1945; 804 pages, $15.

This is a revised American edition of a treatise in which the mathematical aspects of Bessel functions are discussed. In writing this book the author had two primary objectives in view. The first was the development of applications of the fundamental theory of functions of complex variables. The second was the compilation of a collection of results which would be of value to the increasing number of mathematicians and physicists who encounter Bessel functions in their investigations. Extensive bibliographies and tables are included in the volume, which is intended for students and research workers who wish to obtain an intimate knowledge of Bessel functions.

Acme Threads; American Standards Association, New York, 1945; 24 pages, $0.50.

The results of the work of a committee organized to develop an American War Standard for special Acme screw threads for aircraft are given in a booklet of 24 pages. The new standard is described in the text matter, with regard to the specifications for the Acme form of thread, the classifications and tolerances, the limiting dimensions, symbols, and gages. Drawings illustrate the form and dimensions of the thread, and detailed specifications are contained in a series of tables.

Radiant Heating and Cooling, Parts I and II, by C. O. Mackey, L. T. Wright, Jr., R. E. Clark, and N. R. Gay; Cornell University, College of Engineering, Ithaca, N.Y., 1943 and 1944; Part I, 13 pages, Part II, 16 pages, $0.40 each.

The first of a series of bulletins giving the results of investigations of the economy and comfort of radiant heating and cooling concerns angle factors for calculations. It supplies preliminary engineering data necessary in the study of radiant heat exchanges within a room and useful for many other purposes, including the study of radiant heat exchange within a boiler furnace, and studies of illumination. Charts are supplied for angle factors from plane surface to plane surface, and from a small sphere to plane surfaces. Tables give the angle factors for the surfaces within a specific test room.

Part II, by C. O. Mackey, refers to thermal environment and radiant heating. It discusses the variables that affect the rate of heat loss from a human body to its surroundings.

Experimental Stress Analysis; Addison-Wesley Press, Inc., Cambridge, Mass., 1945; 166 pages, $5.00.

Volume II, No. 2, of the Proceedings of the Society for Experimental Stress Analysis contains papers presented before the Society's 1944 Fall meeting and symposium on crankshaft stresses.

In addition to the papers, with their illustrations, charts, and drawings, the volume contains lists of officers of the Society, its Corporation Members, and its individual members. The papers and writers are as follows: "Shot Peening to Improve Fatigue Resistance," by O. J. Horger and H. R. Neifert; "The Magnetic-Coupled Torquemeter," by B. F. Langer and K. L. Wommack; "Analogic Experimental Methods in Stress Analysis as Exemplified by Saint-Venant's Torsion Problem," by Thomas James Higgins; "The Load Distribution in Riveted and Spotwelded Joints," by B. J. Aleck, M. Goland, and L. D. Morris; "Electric Method for the Solution of Laplace's Equation," by V. Paschkis; "Residual Stress Study," by R. W. Graves, E. C. Kirstowsky, and C. Lipson; "Studies of Plastic Flow Problems by Photo Grid Methods," by C. P. O'Haven and J. F. Harding; "Electrical Analogy for Shear Lag Problems," by R. E. Newton; "New Approaches to Engineering Design," by R. C. Pocock, R. H. Peterson, and E. E. Stilson; "Electric Gaging Methods: Their Selection and Application," by Howard C. Roberts; "Instruments for Aircraft Strain Analysis," by H. Reno; "Structural Evolution of a Crankshaft," by S. Oldberg and C. Lipson; "Determination of Operating Loads and Stresses in Crankshafts," by Alexander Goloff; "Full Scale Fatigue Testing of Crankshafts," by C. W. Gadd and N. A. Ochiltree; "The Metallurgy and Processing of the Packard-Built Rolls-Royce Merlin Crankshaft," by Muir L. Frey.

Development and Regulation of Civil Aviation; Transportation and Communication Department, Chamber of Commerce of the U.S.A., Washington, D.C., 1945; 16 pages.

The report of the Transportation and Communication Department Committee has been reprinted in the form of a 16-page pamphlet. It contains a summary of recommendations in regard to primary air lines, contract carriers, scheduled feeder and local services, fixed-base operations, private flying, aviation training, research, airways, airports, and administration. The discussion of the recommendations is considered under the foregoing headings.

Books, Publications, and Patents of Battelle Memorial Institute Staff, 1929–1944, compiled by Thelma R. Reinberg; Battelle Memorial Institute, Columbus, Ohio, 1945; 72 pages.

This is a 72-page catalog of the publications and patents that have resulted from 15 years of fundamental and applied research conducted by the Battelle Memorial Institute. In it are listed more than 800 journal contributions, books, and patents, between the years 1929 and 1944 inclusive. The catalog includes subjects in the fields of organic chemistry, electrochemistry, chemical engineering, graphic arts, welding technology, applied mechanics, mineral dressing, industrial physics, ceramics, fuels, and metallurgy.

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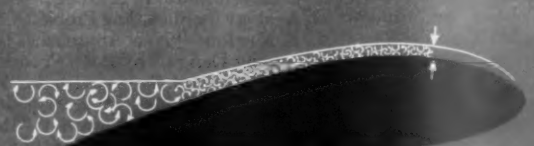
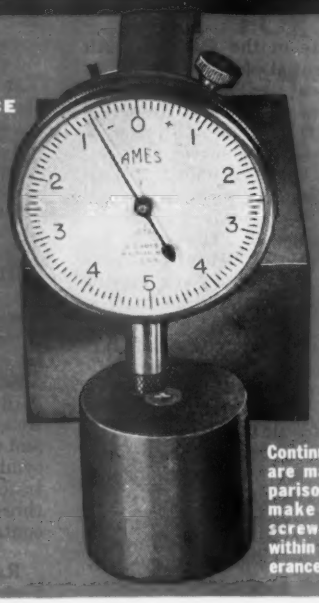


Diagram above illustrates effect on air flow on upper surface of air foil when turbulence is caused by lack of flushness of screw heads.

This diagram illustrates how turbulence is reduced when roughness of surface is eliminated by use of Laminar Flow Screws.



Continuous checks are made in comparison gauge to make sure that screw heads are within required tolerances.

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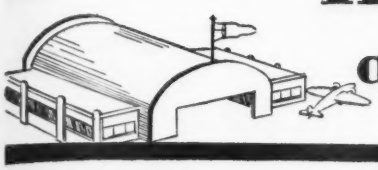

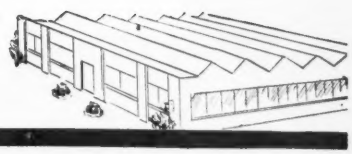

Instrument Requirements for Private Aircraft

Report of Survey Made by Kollsman Among Members of the Aircraft Owners and Pilots Association on Their Instrument Requirements. This report analyzes the replies to questionnaires by 2,745 members and shows the types of planes owned, the purposes for which the planes are used, and a comprehensive study of present instrument equipment and additional equipment desired.

In addition there are tables showing the amount of cross-country flying, and new plane purchase plans with prices expected to be paid for new planes. A digest of suggestions made by the members is also included. Supplementing the text explaining how the survey was made is a chart presenting the figures. *Kollsman Instrument Division of Square D Company.*

Data Concerning Plastics

Vinylite Plastics, Resins, and Bakelite Resins are described in booklets giving technical information about these products. *Vinylite Plastics* contains a description of the methods of bonding the material, tabulated figures concerning their chemical composition, and instructions for bonding the plastics to other materials.

Vinylite Resins discusses the chemical structure of the material and lists the applications for which it is suitable. Information is also given about the methods of fabrication and uses of the different forms in which the material is available. *Bakelite Dispersion Resins* defines those products and describes their properties and uses in the protective coatings industry.

Bakelite Resin Baking Coatings discusses the types of surfaces that can be coated, methods of application, properties, and industrial applications. Technical data on cast resins are given. It deals with types, properties, fabrication, and uses of cast resins.

A Simplified Guide to Bakelite and Vinylite Plastics defines the different products, describes them briefly, and illustrates their use in finished articles.

Bakelite Laminating Plastics contains definitions and descriptions of laminated plastics in their various forms, shows how they are made, and illustrates their uses.

Vinylite Rigid Sheets Plastics contains technical data and fabrication information. The properties of the product are tabulated and the processes of machining, forming, cementing, and finishing are described. *Bakelite Corporation, Unit of Union Carbide and Carbon Corporation.*

Pocket Manual on Rivets

Manual D-45. A 20-page booklet contains pertinent details regarding basic types, installation methods, and applications of a line of rivets. Self-plugging and hollow rivets in various styles, sizes, and alloys are described. Of particular interest is the comparison between blind riveting and pull riveting.

Typical applications in such materials as sheet metal, fabric, plywood, plastic, rubber, leather, and enamels are listed, together with interesting facts about riveting thin sheet-metal assemblies, fairings, subassembly jig work, and tubes. One section of the manual lists 20 types of rivets designed for a variety of materials and uses. Application guns, angle adaptors, flat face nippers, etc., are described and illustrated. *Cherry Rivet Company,* Los Angeles.

Self-Sealing Couplings

Bulletin No. 107 describes Aeroquip self-sealing couplings. The text describes the construction of this style of coupling and methods of disconnecting it. Drawings illustrate the interior structure. Specifications and pressure data are tabulated. *Aeroquip Corporation,* Jackson, Mich.

Camera Specifications

Condensed Specifications of Fairchild cameras are given in a data sheet, perforated for insertion in a binder. It gives detailed specifications of 31 different models of Fairchild cameras, with columnar listings of camera type; method of operation; purpose; lenses, speed, and focal length; shutter speeds and type; type of focal plane; negative size; film capacity; and number of exposures. *Fairchild Camera and Instrument Corporation.*

Electronic Applications in Aeronautics

Harnessing Electronics to Postwar Aviation. Charles Marcus. The Vice-President in charge of Engineering of Bendix Aviation Corporation predicts the future role of electronics in aviation. He explains how the utilization of electronic principles and products will promote the progress of aviation. Three phases of aircraft operation in which electronic devices will play an increasing part are discussed. These are ground operation, avigation, and flight control. *The Pegasus,* July, 1945.

Catalog of Plastics

From Blueprint to Product in Plastics. A booklet of 24 pages contains descriptions and illustrations of numerous products made from plastics. These include instrument dials, calibrated scales of various sizes, plastic crystals, aircraft navigational computers and calculators, industrial calculators and computers, name plates, templates, charts, and miscellaneous industrial parts and models. *G. Felsenthal & Sons,* Chicago.

Manufacture and Use of Superchargers

Supercharging for Greater Power and Improved Performance is the title of a catalog illustrated in colors. It contains a brief, nontechnical discussion of the principles of supercharging; illustrations and descriptive captions showing the production of various parts of these devices in the plant of the manufacturer; and information about the application of superchargers for highway, rail, marine, and stationary internal-combustion power plants. *Superchargers, Inc., Division of Borg-Warner Corporation.*

Instruments for Passengers' Use

Sketches of Passenger Cabin Indicators. A 4-page folder contains a sheet giving sketches and suggested arrangements of aircraft instruments to be located in the passenger compartment of a transport airplane, so that passengers may keep in touch with the operation of the aircraft. The sketches show suggested arrangements of dials of such instruments. *Kollsman Instrument Division of Square D Company.*

Packing and Sealing Materials

Johns-Manville Products for the Aviation Industry. Packing and sealing products, tubing, insulation, tapes, gaskets, and similar products are described and illustrated in a book of eleven pages. Asbestos fiber, synthetic rubber, resins and plastics, and mineral fibers are among the more important basic raw materials used in the manufacture of these products, which find employment in a wide variety of applications in aircraft power plants, propellers, accessories, and elsewhere. Other materials listed in the catalog include brake linings and insulation. *Johns-Manville Corporation.*

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"The Stress-Strain Characteristics of Cold-Rolled Austenitic Stainless Steels in Compression as Determined by the Cylinder Test Method" — describes a method for determining compressive strength of thin sheets of these steels; it is illustrated by curves from the tests on typical grades of stainless steel.

"Effects of Low-Temperature Heat-Treatment on Elastic Properties of Cold-Rolled Austenitic Stainless Steels" — a 16-page paper, illustrated by charts and graphs, on the results of various low-temperature heat-treatments on the mechanical properties of cold-rolled austenitic stainless steels.

"High-Manganese Austenitic Steels" — physical data on new high strength steel, for possible use in aircraft construction and in other light weight structures.

"Tension and Compression Stress-Strain Characteristics of Cold-Rolled Austenitic Chromium-Nickel and Chromium-Manganese-Nickel Stainless Steels" — a compilation of important physical data on austenitic chromium-nickel and chromium-manganese-nickel steels.

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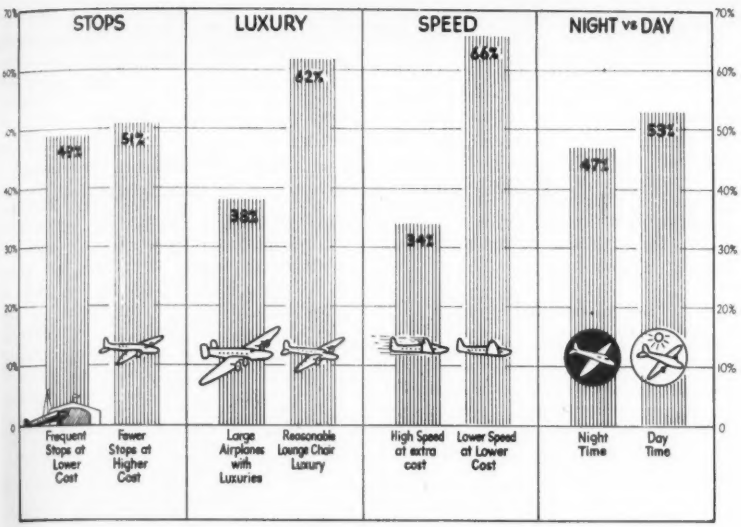

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Preferences in air travel—night flight versus day flight.

Travel and Vacation Survey

Survey 1944–1945, Travel, Recreation. In an analysis of vacation-travel facilities in which the preferences of the public with regard to prewar and postwar vacation travel were ascertained, a special section is given to air-line travel. The travelling public's desires were expressed in answers to questions and these are analyzed, tabulated, and charted. In general, the figures show a favorable attitude toward air travel. A chart shows the percentages of those who expressed wishes with regard to number of stops, luxury of travel, speed, and the choice between night and day travel. The survey was made with the cooperation of the New England Council, Boston. *Charles W. Hoyt Company, Inc.*, New York.

Flexible-Shaft Equipment

Kellerflex Flexible Shaft Machines and Accessories are described in a 48-page illustrated catalog. The booklet shows the machines and describes a large selection of the various handpieces, attachments, and accessories that adapt them to a great variety of mechanical work. Detailed specifications are also included. Illustrations include drawings showing the internal construction and photographs of a large number of applications of the equipment. *Pratt & Whitney Division of Niles-Bement-Pond Company*, West Hartford, Conn.

Blind Riveting

Bulletin 451 describes the operation, advantages, installation, and inspection of the Huck blind-riveting process. It explains the construction of the rivet and details the mechanical steps that take place during the riveting operation. Recommendations are included for the proper procedure for performing work with this type of fastener. *The Huck Manufacturing Company*, Detroit.

Vertical Milling Machine

Rogers "Perfect 36" Vertical Turret Mills are described in an illustrated booklet of twelve pages, which shows the special features of this group of machine tools, as well as illustrations of typical operations and installation in the plants of users. One page contains operation charts, with tabulated data concerning the operations that can be performed. Specifications of the mills are given. *Rogers Machine Works, Inc.*, Buffalo, N.Y.

Catalog of Lathes

Catalog 9-G describes 9-in. South Bend precision lathes. The features of this group of lathes are outlined, followed by detailed descriptions of each of several different types designed for specific purposes. Specifications for each model are tabulated. Numerous attachments are described and illustrated. *South Bend Lathe Works*, South Bend, Ind.

Vibration-Testing Equipment

Postwar Competition Demands Rigid Product Testing is the title of Bulletin 425. It describes the manufacturer's group of testing equipment for research and development laboratories, as well as fo inspection and testing departments. Descriptions are given of the various machines, together with specifications and lists of users. *All American Tool & Manufacturing Company*, Chicago.

Fabrication Service

Welded Assemblies Fabricated at Ampco is the title of Bulletin 67, which describes the facilities of the manufacturer for producing assemblies made of bronze sheet, castings, or extruded parts welded with Ampco-Trode aluminum bronze weld-rod. Illustrations show the types of assemblies produced and indicate the versatility of the organization. *Ampco Metal, Inc.*, Milwaukee.

Index of Standards

American Standards is a booklet of 24 pages containing lists of approximately 800 standards representing the cumulative work of the past 26 years on the part of many hundreds of trade, technical, and governmental groups working through the American Standards Association. The standards are listed alphabetically, as well as by engineering fields. There is also a separate list of the War Standards, comprising assignments completed since the entry of the United States into the war, at the specific request of the Army, Navy, or industrial groups. *American Standards Association.*

Control-Tower Air Conditioning

How to Air Condition an Airplane Control Tower. A brief description is given of the equipment and construction methods used in providing air conditioning for an airport control tower. The various construction problems encountered and the operation of the mechanism are discussed. *Trane Weather Magic*, May-June, 1945.

Aero Research Technical Notes

Flexible Bag Moulding with Aerodux 14. A discussion is given of the technique of molding resin-bonded plywood having curved surfaces, by the flexible-bag method. The bulletin outlines the requirements for a satisfactory adhesive, gives detailed directions for mixing and spreading the adhesive, and formulas for alternative mixes. Additional ins ructions refer to the assembly time, the pressure requirements, and the temperature limits. *Bulletin No. 30, Director of Research and Development, Aero Research Limited*, Duxford, Cambridge, England.

Fairchild Packet Picture-Folder

The Fairchild Packet is described briefly in a file-sized folder that contains a group of photographs illustrating the capacity of the C-82 Packet for carrying large items of air cargo. The pictures show the construction of the cargo space on lines similar to those of a freight car, permitting the storage of large units, such as a military tank and an automobile. Sketches show the dimensions of the airplane and methods of loading it. *Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation.*

Postwar Problems

Do You Need Help On Your Postwar Products and Production? is the title of a leaflet explaining the services of an engineering organization that offers assistance in solving technical problems. It is explained that the organization advises on a full range of manufacturing problems, from the layout of the plan

through product engineering, tooling, and production planning, to the delivery of the finished product. *The O. L. Woodson Company*, Los Angeles.

Pressure-Sealing Zippers

New Openings for Tomorrow's Aviation is a 4-page folder illustrating and describing the use of the pressure-sealing zipper closure designed to prevent the passage of gases or liquids. The construction, applications, and specifications of the fastener are given. *The B. F. Goodrich Company.*

Improved Hydraulic Packing

Weatherhead T-Ring Packing is discussed in an 8-page leaflet. The features of this design of packing, intended to eliminate the damaging effect of extrusions into the clearance space are explained. Instructions are given for installation. Test data are tabulated. *The Weatherhead Company*, Cleveland.

Tube-Forming Machine

Vaill No. 7 Tube End Forming Machine is a catalog that describes beading, flaring, flanging, expanding, reducing, and changing the shape of metal tubing. The machine is described as a compact and powerful double-action hydraulic press, which operates automatically. The 8-page catalog explains the functions and operations of the machine and its applications to a variety of work. *Vaill Engineering Company*, Waterbury, Conn.

Helicopter Catalog

The Bell Helicopter—A New Kind of Flying is the title of an illustrated catalog in which the manufacturer endeavors to remove some of the misconceptions that appear to exist in connection with helicopters and their potential uses. The principles of the Bell helicopter are explained and its design, performance, operation, and potential uses for vertical-lift aircraft are discussed. *Bell Aircraft Corporation.*

Forging Terminology

Glossary of Forging Terms is a booklet of 20 pages containing a list of definitions of the terms used in connection with forging operations. The words and terms are defined as they are used in forging practice. Some of the definitions are illustrated by small sketches. *Kropp Forge Company*, Chicago.

Products for Aircraft Use

B. F. Goodrich Aeronautical Products is a combined catalog and buyer's guide with engineering data, in condensed form. Among the products illustrated and described are some comparatively new special developments that are finding wide applications in the industry. These include pressure-sealing zippers, the Flex-lock joint for making vibration-proof, leakproof couplings on "plumbing" lines, and Plastilock 500, a rubber cement that provides superior binding for metals, plastics, and wood. Other pages show bullet-sealing fuel cells, deicing equipment and abrasion shoes, airplane tires, airplane hose, and accessory rubber products. Six pages are given to tire data and two to riveting. *The B. F. Goodrich Company.*

Results of Training Program

Report on the Fairchild Maintenance and Training Program for Army and Navy Personnel gives the details of an instruction course provided for Army and Navy trainees, for the purpose of instructing them in the operation and maintenance of aircraft photographic equipment and in aerial photography work. Brief descriptions are given of the various schools operated, together with descriptions of the facilities and pictures taken in some of the classes. General outlines are given of the different syllabuses and courses. *Fairchild Camera and Instrument Corporation.*

Production and Maintenance Suggestions

McDonnell Bulletin, June 15, 1945. (1) A prick punch to be put in the trailing edge of a cowl die as the first operation on a drop hammer eliminates about 80 per cent of rework; (2) idea for making a sheet-metal clip approximately three times stronger in tension and compression increases the rigidity of sheet-metal angle, channel, and stringer.

Republic Aviation News, June 16, 1945. (1) Improved method for leveling thermocast blocks reduces time necessary for the operation and releases a machine for other work; (2) joggle stop gage reduces time for joggling cap strips; (3) air ejector attachment for cutting small bushings and spacers automatically ejects the part as it is cut and deposits it in a container; (4) use of a hand pump for oiling spare oleos assures thorough lubrication job.

The Menasco Flying M, June 1, 1945. (1) Method of drilling and tapping the air valve hole in the main hydraulic cylinder eliminates the "out of round" condition; (2) tool-setting gage eliminates one chucking operation on the piston tube.

North American Take-Off, June 15, 1945. A special catch enables conveyer dollies to be easily attached to the chain on the engine runup line.

North American Skywriter, June 8, 1945. Cherry rivet shank cutter saves time and labor.

Consolidated Vultee Volunteer, June 8, 1945. Checking fixture for inspecting elevators.

Oklahoma City Douglas Airview News, June 2, 1945. (1) Air lift for Walker-Turner radial drill press; (2) a guide to facilitate installation of soundproofing and also to hold soundproofing in place.

The Pratt & Whitney Wasp Nest, June, 1945. Special fixture permits exact facing of the gun-drive bushings before the installation of studs and washing of the crankcase.

STURTEVANT
Sensory
TORQUE WRENCH
-HEAR-FEEL-SEE-
This wrench "CLICKS" with Management because Reflex Torque Control is far faster and is uniformly accurate.
It "CLICKS" with Operators too, because it eliminates eyestrain and need for sustained close attention.
It "CLICKS" with Tool Buyers, for it is fast under all working conditions (in bad light, blind spots or deafening noise). The STURTEVANT Sensory Torque Wrench is permanently accurate.
31 Capacities—ranges from 0-8 inch ounces to 0-7200 inch pounds.
10 clicks
Much Faster
More Accurate
Long, Long Life!
Records through 3 senses simultaneously the instant the desired torque is reached. Makes torque control automatically fast, automatically accurate.
Write for Bulletin No. S.W. 1
P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS
THE WORLD'S LARGEST MANUFACTURER OF TORQUE WRENCHES

He's ridden that bulldozer 100 hours this week. He's been bombed 18 times. He's had just three hot meals. And he's still riding that bulldozer. He and his outfit have turned a jungle into an airfield in just 7 days—and hacked a road through from the beachhead.

These are the guys who built our airfields in China, in Alaska, in Guadalcanal, in Saipan, and on Leyte. On their shoulders our air forces have moved up and up and up until now they are hitting hard at the very heart of Japan. These men of the Combat Engineers and Construction Battalions are every inch as much rugged pioneers as any man in our history books. In them today lies high promise for America's tomorrow.

Yes... this flinging of airpower round the globe has called for *human* pioneering on a scale never seen before. And for industrial pioneering to match it... in materials, in fuels and lubricants able to withstand undreamt-of extremes of temperature, altitude and speed.

Riding high, wide....and Hopeful!

A *QUICK PICTURE* of some of the startling new aviation fuels and lubricants pioneered by Esso Aviation Products...

Univis J-43, a hydraulic oil that provides satisfactory operation of aircraft hydraulic mechanisms at temperatures varying from minus 80° F. to above 150° F.

Beacon Lubricant M-285, a grease that helps resist melting up to 370° F. and yet operates freely at minus 67° F.

Esso Aviation Oil—the only oil in the world to win approval from all leading American and British aircraft engine builders.

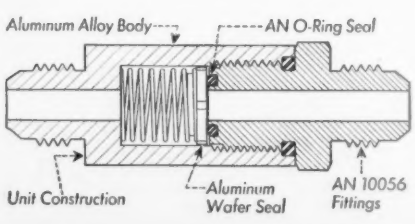
Esso Aviation Instrument Oil—the first oil approved under Army-Navy Specification AN-O-4.

The full list would run into scores of products, some developed in close conjunction with the Army and Navy and the Aviation Industry. Forty years practical aviation experience, the country's largest research facilities and abilities back the promise that "You can *depend* on Esso Aviation Products."

YOU CAN DEPEND ON

VERSATILITY

PLUS WEARABILITY



ELECTROL'S CHECK VALVE

Here's a check valve, meeting AN-V-5 specifications, with a minimum number of parts. It provides hydraulic control lines long-life positive sealing against return flow, requires no servicing, and is low in cost. It works equally well in simple circuits on personal aircraft or complex applications in transport and cargo plane hydraulic control.

The two-piece valve body, of aluminum alloy, has integral AN 10056 fittings. A spring-loaded aluminum wafer seal, guided in the valve body, seats directly on a standard AN o-ring fitted in with a slight initial squeeze. Only light spring pressure is required for positive seating. Progressive design has eliminated poppets, hardened and ground seats, and guide stems—all requiring expensive machining and assembly. The result is a service-free valve design of high sealing efficiency, extremely effective at low pressures, yet equally adaptable to high pressures.

Remember these design advantages when you select check valves for your present or postwar control systems. ELECTROL hydraulic control units: check valves, unloader valves, relief valves, selector valves and cylinders are now providing dependable wartime service around the world. They are manufactured in sizes to meet all aircraft hydraulic requirements. Engineering service is available to help you solve your control problems.

ELECTROL, INCORPORATED, KINGSTON, N. Y.

ELECTROL

HYDRAULIC CONTROL DEVICES

The Consolidated Vultee Volunteer, May 25, 1945. A definite method for determining correct lengths and position of power-control cables.

Edo Weekly Log, April 25, 1945. (1) A jig for insuring the correct dimension between the angles of the strut eliminates former hand-hammering operation and assures better job; (2) a special clamp for holding the "J" hook drill jig against the airplane float reduces amount of man power required for the operation.

Douglas Airview, May, 1945. (1) Milling fixture for boring and counterboring increases rate of production by 15 times; (2) drill jigs for locating holes the same distance apart on all fuselage stations facilitates cloth strip installation; (3) change in design of blank dies and method for boring stiffeners enables excess material to be cut out of part at bending edge and eliminates cracking at bend line; (4) installation of new pipe lines, valves, and extra pump on the solvent system enables three tanks to be simultaneously filled, tested, and drained; (5) a straightaway gage for turret gun installation facilitates installation of the guns and improves their efficiency; (6) easter stands for nacelles facilitates handling of the nacelles and enables women to perform the moving operation; (7) mechanic's workstand for engine mount and ring cowl permits operator to adjust engine without help and protect the engine from propeller blast and weather; (8) method of welding tools made from carpenter's Stentor and Graphmo saves time and steel; (9) improved angles on milling cutter adapted for use on variety of extrusions eliminates burring operation.

In fitting together sections of the curved metal skin on the wings and fuselage of an airplane, a new type of edging tool enables the edges to be finished at the exact angles required. This small tool holds a file at any specified angle and can be attached either to a rigid bracket or a movable carriage. The tool was invented by an employee of The Glenn L. Martin Company and has been patented.

Chance Vought News, June 28, 1945. Holding and riveting tool for installing nut plates on the pilot's main instrument panel.

Ryan Aerolite, June 16, 1945. Pouring molten Kirksite over the die in drop-hammer operations eliminates the use of rubber for preventing the part from being formed too severely in any one phase of the operations.

North American Take-Off, June 22, 1945. Quick-acting clamp aids in the setup of drill-grinding machines.

Kellett News, June 15, 1945. (1) Substitution of dimpling for countersinking on aileron trim tabs; (2) mesh screen with handle scoops grease and foreign matter from anodizing tanks; (3) anchor nut locator for fairing.

Ryan Aerolite, June 2, 1945. (1) Improvement in welding table enables it to be used on flange nipple weld joint; (2) a vibration dampener for a spar mill eliminates vibration causing rough finish; (3) combination welding, cutting, and alignment jig for airplane clamp results in interchangeable parts; (4) special handle for lifting spar mill results in greater safety and a saving of time; (5) attachment of an angular or straight cutter jaw to a rivet squeezer eliminates hand clipping, speeds work, and results in a more efficient job.

Douglas El Segundo Airview News, June 12, 1945. (1) Plastic coating material waterproofs master plaster patterns; (2) a router guide increases efficiency of the operation in cutting holes in airplane access doors.

Noorduyn Tale-Spin, June, 1945. (1) Boning fixture produces smooth finish and perfect fit, eliminates rework, and reduces fatigue formerly experienced by operator; (2) machine cutter for cowl front skin performs accurate job and effects saving of time and labor; (3) jig for bending wire more quickly also results in a better and cleaner job; (4) burring device saves time and man hours, eliminates rejections, lessens fatigue; (5) roller instead of brush for use in painting bars, tubing, and sheeting is faster and more economical; (6) special anodizing process saves aluminum wire, economizes on electrical energy, reduces number of necessary operations.

Library Facilities of the

Institute of the Aeronautical Sciences

To serve Institute members and others in the aeronautical industry, the Institute of the Aeronautical Sciences offers the facilities of:

The W. A. M. Burden Library
1505 RCA Building West
30 Rockefeller Plaza
New York 20, N. Y.

The facilities of this library are available for reference study at the offices of the Institute.

The Paul Kollsman Library
1505 RCA Building West
30 Rockefeller Plaza
New York 20, N. Y.

This library loans books without charge to members and others in the United States over eighteen years of age. Full information will be sent on request.

The Pacific Aeronautical Library
6715 Hollywood Boulevard
Hollywood, Calif.

This is a service and reference library for West Coast organizations. Full information as to its facilities will be sent on request.

ELECTRIC MUSCLES

OK FOR SUPERFORTRESSES!

LANDING FLAP ACTUATOR MOTORS · TAIL-SKID ACTUATOR MOTORS · RUDDER SERVO-MOTOR · CAMERA MOTORS · BOMB SIGHT GYRO-MOTORS · BOMB-BAY DOOR COMPRESSOR MOTORS · TURRET DRIVE MOTORS · AMMUNITION BOOSTER MOTORS · HEATER MOTORS · AILERON SERVO-MOTOR · AUTOMATIC PILOT GYRO-MOTORS · COWL FLAP ACTUATOR MOTORS · ELEVATOR SERVO-MOTOR · DEFROSTER MOTORS · FUEL PUMP MOTORS · MAIN LANDING GEAR ACTUATOR MOTORS · BOOSTER PUMP MOTORS

WESTINGHOUSE LONGER LIFE AIRCRAFT MOTORS...

FOR EVERY AIR-BORNE APPLICATION

1/6 H.P.

Westinghouse pioneered in the development of aircraft motors . . . in research, design, engineering. Using finest materials and manufacturing methods, Westinghouse motors for aircraft have kept pace with aeronautical progress. They are light in weight and small in proportion to their ratings. A wide variety of sizes and ratings are available to meet individual requirements.

1/4 H.P.

This totally-enclosed motor with brake (top) has an intermittent rating of 1/6 hp, 7500 rpm at 26 volts. Weight, 2 pounds, 6 ounces.

•

11 H.P.

This totally-enclosed fan-cooled motor (center) is rated 1/4 hp continuous, 9800 rpm, at 27 volts. Weight, 4 pounds.

•

This open-type, blast-cooled motor (bottom) provides 11 hp continuously at 6000 rpm, 26 volts. Weight, 46 1/2 pounds.

A big OK has been given to electrical operation of important functions aboard Allied bombers and combat planes . . . thanks to the high efficiency and dependability of electrical distribution, aircraft motors and generators. An important portion of rotating electrical equipment is supplied by Westinghouse. There are two basic reasons:

1. Westinghouse supplies a wide range of motors, generators, dynamotors and actuators. This equipment has been extensively tested in the Westinghouse high-altitude test chamber which reproduces accurately the conditions encountered by aircraft at altitudes as high as 50,000 feet.

2. The high-altitude brush treatment . . . developed by Westinghouse . . . has tremendously increased brush life in the stratosphere. Under certain conditions ordinary carbon brushes wear away rapidly at stratosphere levels, because of the loss of a lubricating oxide film on the commutator. Westinghouse engineers developed chemical treatments for brushes that maintain this lubricating film.

From combat planes, which engage in dog fights at 40,000 feet, to huge bombers which must fly at high altitudes for many hours, Westinghouse has supplied a varied assortment of rotating apparatus. The experience and skill developed by decades of Westinghouse leadership in motor design are yours today to help solve any motor application problem. Call your Westinghouse office, or write Westinghouse Electric Corporation, Lima, Ohio.

J-03220

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

AIRCRAFT MOTORS

From the Industry

Turnbuckle Adjustment Set

The Aero Tool Turnbuckle Adjustment Set consists of a turnbuckle wrench and two V-shaped retainers that are connected by a 12-in. length of link chain. When the retainers are dropped over the swaged-cable fitting, converging "steps" in the retainers find their own adjustment automatically on any fitting from $^3/_{16}$ in. to $^{11}/_{16}$ in. in diameter. The weight of the chain holds them in position, and a setscrew is provided for use when needed. The chain acts as a rigid bar against the simultaneous clockwise and counterclockwise torque of the swaged cable fitting set up when the turnbuckle is turned, while its vertical flexibility permits adequate clearance in the tight spots.

The turnbuckle wrench is self-adjusting and the makers state that its grasping surfaces cannot scratch or mar the turnbuckle. The grip automatically tightens as the wrench handle is pressed down, automatically releases and slides smoothly around the turnbuckle to a new grasping position when the handle is raised. Aero Tool Company, Burbank, Calif.

Eliminating Vapor from Cutting Fluids and Coolants

A new low-cost means has been developed for stopping and collecting vapor from oil or cutting fluids (arising from cutting, grinding, and similar operations) and returning it to the source of its supply. The new vapor collector is for use on virtually any type of high-speed production machine tools employing cutting oils or coolants, such as screw machines, thread grinders, centerless grinders, wet carbide tool grinders, etc. It employs a motor-driven multiple-blade fan to provide suction for drawing the vapor from the vicinity of the operator and the work. The vapor-laden air is sent against the inside surface of the spun-glass filter material where the vapor condenses and is collected in the pan, the cleaned air being recirculated into the working space. The collected fluid is returned to the sump or reservoir of the machine tool through the faucet provided on the pan.

Having a suction capacity rating of 500 cu.ft. per min., the collector is said to be capable of stopping all the vapor from the largest type of machine tools employing cutting or similar fluids that cause vapor and mist. Installation is quickly made with either ordinary sheet-metal pipe or flexible metal hose of 5-in. diameter which fits the inlet flange of the collector and can be located near the source of the vapor.

The standard motor to drive the fan and provide the suction is a $^1/_3$-hp., 3,450 r.p.m., continuous-duty type, for operation on 220 volt, three-phase, 60-cycle a.c. Units for operation on power sources of other voltage and frequencies are available on order. Aget-Detroit Company, Ann Arbor, Mich.

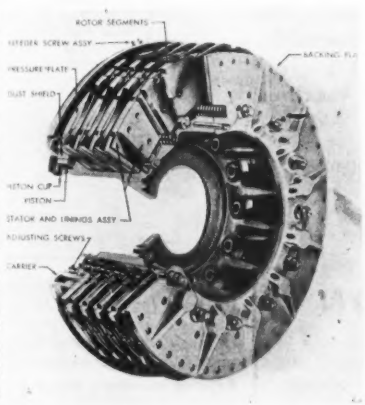
Molded Holder for Radio Crystals

Quartz crystals, used in radio equipment to effect instant changes in prearranged wave lengths, are protected against moisture-laden atmosphere and shock by dimensionally stable, lightweight crystal holders, molded from water-resistant phenolic molding material. Chemically inert, this phenolic material, when molded, maintains the accuracy of the unit by guarding the quartz crystal against deterioration from moist salt air. Acting as a moisture barrier, the molded crystal holder prevents corrosion of the sensitive metal components of the assembly. Bakelite Corporation, Division of Union Carbide and Carbon Corporation.

Airacomet at Smithsonian Institution

Through an arrangement between Gen. Henry H. Arnold, Commanding General of the Army Air Forces, and the Smithsonian Institution, the No. 1 model of the P-59 Airacomet series, still bearing its original camouflage paint, has been retired from active service after $2^1/_2$ years of operation, and placed on permanent exhibition in the Smithsonian Institution at Washington.

The XP-59 is stated to be the first aircraft of World War II, in fact the only modern airplane, in the Aircraft Section of the Smithsonian Institution. It is displayed in position 6 ft. from the floor, with its landing gear in a retracted state. Bell Aircraft Corporation.



Bendix Aviation Corporation's new segmented rotor disc aircraft brake.

Segmented Rotor Disc Aircraft Brake

Following intensive laboratory and Army and Navy flight tests, which recorded as many as 200 landings in 150 flying hours, the "segmented rotor disc" aircraft brake is now in production. Weight savings as high as 500 lbs. on one of the larger experimental bombers were achieved by replacing a shoe-type braking system with a test installation of the new assembly.

The "segmented rotor disc" assembly consists of three major parts, the main carrier structure containing a hydraulic pressure chamber, piston, and hydraulic seal; the lining carrier members, which are loosely keyed to the brake carrier; and the heat-absorbing elements called "rotors," which are installed in sections or segments instead of in a continuous ring.

Brake lining is riveted to carrying members to prevent them from rotating, but allowing them to slide laterally. The riveting is done in a manner that permits air to circulate easily through the brake. The "segmented" construction of the rotors, which rotate with the wheel by means of key fastenings, is stated to eliminate warping and allow for greater heat absorption. Brake adjustments on the system are made by three Allen-head screws outside the carrier. This makes adjustments possible without removing the wheels.

The new design is reported to be in production for the Northrop P-61 Black Widow night fighter and the Douglas A-26 attack bomber. Models developed for production range from a single disc 9 in. in diameter to a triple disc 31 in. in diameter, in addition to other designs to meet specialized needs. Bendix Aviation Corporation.

Wider Use for Electronic Recorders

Increased industrial use of electronic recorders has been made possible by stepping up chart speeds of Electronik Pyro-Potentiometers. The standard speed electronic recorder, single- or multiple-point models, incorporates gear changes for speeds of 5, 10, 15, and 20 in. per hour. Fast speed electronic models, single or multiple point, will

One design ON LARGE OR SMALL PLANES gives maximum braking effectiveness

The inherent soundness of the *NEW BENDIX* disc brake design is demonstrated by its ability to meet the braking requirements of all types of planes.

The same principles of construction are applied to brakes ranging from 9 in. to 31 in. in diameter and the same outstanding braking results are obtained regardless of the size or type of plane.

In this new Bendix disc brake, heat absorbing elements called rotors turn with the wheel by means of keys fastened to the wheel itself. These rotors are made in sections rather than in a continuous ring which results in far greater capacity for heat absorption, eliminating fading or warping of either rotating or fixed members.

Also contributing to all around efficiency is the fact that this new design effects considerable weight reduction in wheel and brake assembly.

Thus low hydraulic displacement and greater heat absorbing capacity combine to produce maximum braking effectiveness.

Bendix

PRODUCTS DIVISION

BENDIX AVIATION CORPORATION

SOUTH BEND 20, INDIANA

Bendix* Landing Gear • Bendix Pneudraulic* Shock Struts • Bendix Airplane Wheels • Airplane Brakes • Hydraulic Master Cylinders and Power-Brake Valves make up the list of Bendix Landing Gear Equipment.

*TRADE MARK

***Design Features*—Fixed discs are faced with friction lining; lining is segmented in such a way as to scavenge lining dust and provide air circulation. Eliminates fading and gives greater braking force with less contact pressure.**

Rotating members, keyed to the wheels, provide large heat-absorbing capacity.

Rotors are made in segments instead of a continuous ring; this allows for heat expansion without warping or cracking.

PRODUCT OF Bendix AVIATION CORPORATION

have internally mounted gears for speeds of 10, 20, 30, and 40 in. per hour.

The gears are changed by removing a screw and lifting the gears from the assembly. The new speed gears are then installed and the screw is replaced. Brown Instrument Company Division of Minneapolis-Honeywell Regulator Company.

Checking Rough Surface Finishes

A rough-finish measuring head has been introduced for checking the rougher surface finishes and waviness in metals, glass, plastics, plate, and painted materials. With the trend toward more rigid specifications and tolerances, particularly on turned surfaces, this rough-surface analyzer is recommended as a complement to the original Brush Surface Analyzer. The new pickup and drive head accurately measures irregularities from 100 to 3,000 microinches, peak to valley. It thus extends the use and range of the Brush Surface Analyzer from 1 to 3,000 microinches. The Brush Development Company, Cleveland.

Portable Oxygen Plant

A portable oxygen plant that can be flown to advanced bases has been developed with the cooperation of the National Defense Research Committee, Clark Brothers Company, Inc., and the M. W. Kellogg Company. It can be disassembled into individual pieces, each weighing less than 3,000 lbs., and small enough to be loaded into the cargo hatch of a C-46 transport. With no special supplies other than those ordinarily found at such bases, such as gasoline, oil, and water, the plant can be put into use filling oxygen cylinders within 24 hours after it has been landed. The unit produces more oxygen than previous plants almost twice its weight and a low operating air pressure of 100 lbs. makes it considerably safer than previous plants. Its operation is so simple that enlisted men can be trained to run it in a week's time.

The light weight of the Dri-Oxygen unit was achieved by aviation-type techniques of design. Light fittings and pipings are used throughout. Both the air-borne and trailer units are powered with lightweight aircraft engines. The Clark compressor requires no lubrication other than that supplied by segmental carbon rings on light aluminum pistons running in highly polished chromium-plated cylinders. This method has been used in the past with relatively slow compressors and water lubrication, but the compressor in this unit is high speed, its pistons traveling at the rate of 1,200 ft. per min. The same principle was used in the design of the compressor that charges the oxygen cylinders. Another feature that has made this unit possible was the development of a small but highly efficient expansion engine, designed to operate on 100 lbs. of air pressure. This engine, specially designed for the portable oxygen unit, has an efficiency of over 80 per cent.

The principal part of the unit is the 6-ft. "cold box" where oxygen is produced by liquefying ordinary air, then allowing the liquid to boil in such a way that its oxygen and nitrogen vaporize separately. Temperatures of nearly −300°F. are required to liquefy the air by this process. One of the devices used in cooling the air to this low temperature is a heat exchanger, of which there are 24 in the "cold box," using a total of 11 miles of thin copper ribbon, 0.15-in. wide. This construction has made it possible to keep the size of these exchangers down to 5 ft. Clark Bros. Company, Inc., Olean, N.Y.

Metric Gage Blocks

The makers of Do-ALL precision gage blocks and instruments announce a new series of metric gage blocks designed to fill the needs of domestic and foreign manufacturers working in the metric system. These blocks are offered in two grades that correspond in accuracy with the English system. Inspection quality is guaranteed by the maker to be accurate within ±0.0001 mm. and working quality within ±0.0002 mm.

The set consists of 38 blocks plus 2 wear blocks (of tungsten carbide in the inspection grade) and is capable of producing over 100,000 combinations ranging from 1.01 mm. to 100 mm., in increments of 0.01 mm. A special 1.005-mm. block in the set makes possible special combinations for closer tolerances when needed.

Manufactured from high carbon chrome steel, the blocks are guaranteed by the manufacturer to exceed a hardness of 65 Rockwell C. A special aging process using alternate heating and freezing to −120°F. gives the blocks stability. Precision gage instruments to increase the application of the gage blocks are also available in the metric system. Continental Machines, Inc., Minneapolis.

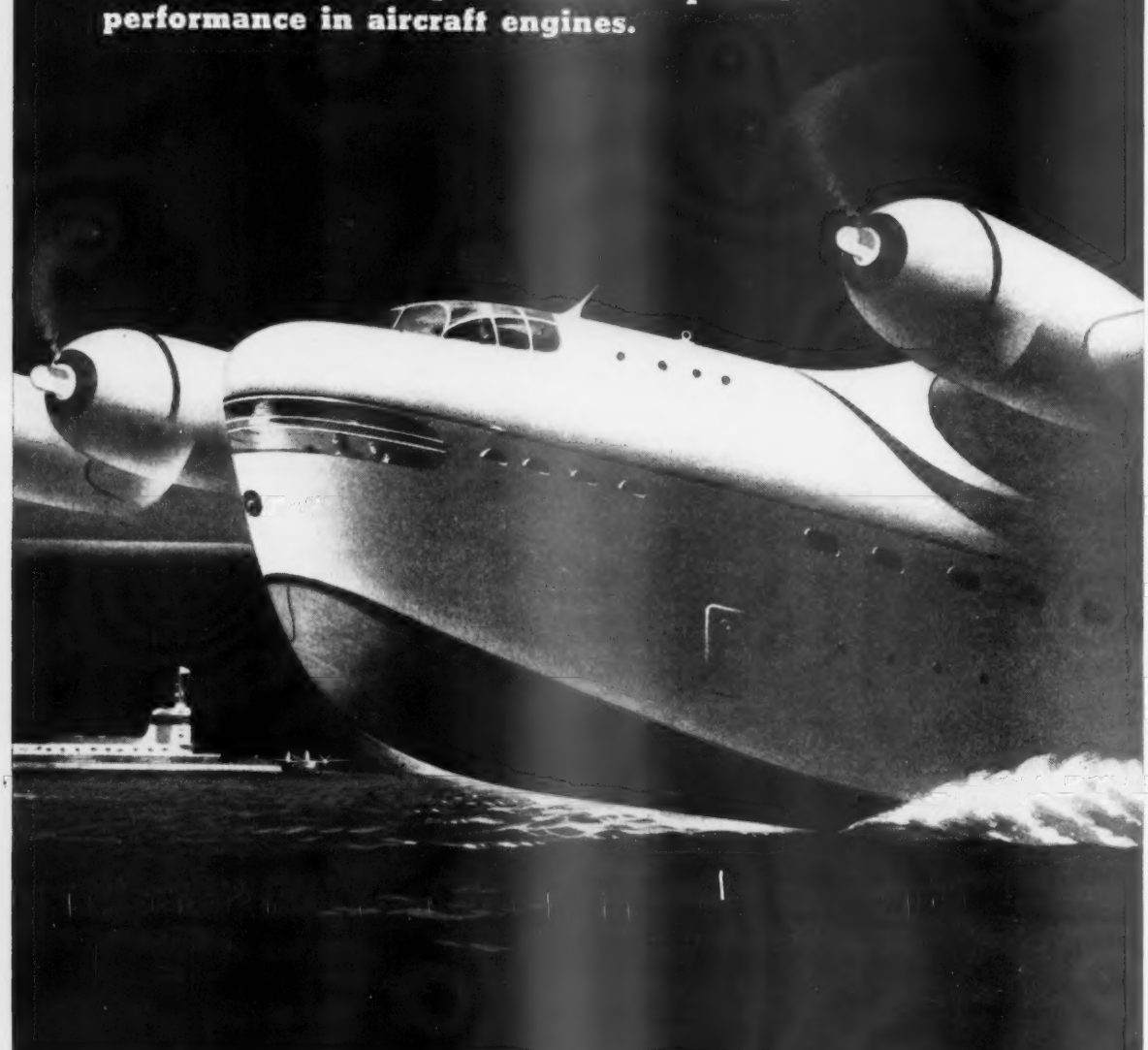
Curtiss SC-1 Seahawk

The new single-seater scout plane, designated as the Curtiss SC-1 Seahawk, is reported to be a development of the Curtiss SB2C Helldiver dive bomber. Like the Helldiver, the Seahawk has a Wright Cyclone engine and a four-bladed hollow steel Curtiss propeller. The engine is a new nine-cylinder model, giving nearly three times the horsepower of the Kingfisher. The propeller has unusually wide "paddle-type" blades to give it the thrust necessary for high performance.

The Seahawk has a bullet-shaped fuselage and a large, stubby cowling for the engine. Wings are straight in the center section, with dihedral in the outer panels, and they fold back along the fuselage for storage on shipboard. Wing tips are square. A bubble canopy of Plexiglas covers the cockpit, giving the pilot 360° vision range. The Seahawk has a main float and two wing floats, although a landing gear can be substituted for ferry operations. Bombs are housed inside the float, which has bomb bay doors controllable from the pilot's cockpit. The float can carry bombs or depth charges, or, when the

The first of the Curtiss Seahawks *(left)*, the Curtiss F7C-1, had a top speed of 150 m.p.h. when equipped with a 450-hp. Pratt & Whitney engine driving a two-bladed Standard Steel propeller. This plane went into naval service in 1929 and could be equipped with floats for catapult duty. The latest Seahawk *(right)* is equipped with a nine-cylinder Wright Cyclone engine driving a four-bladed Curtiss electric propeller.

The dependability of molybdenum steels has been thoroughly established by their performance in aircraft engines.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Avenue · New York City

MOLY

pilot wants more range, he can load the float with auxiliary fuel tanks instead of bombs.

The plane is based on a cruiser or battleship from which it is catapulted. It has two chief functions. The first of these is spotting. The SC-1 can spot enemy fleet units and send warning back to the parent ship. When the fleet is supporting landing operations, the plane can spot gunfire at enemy bases and direct upon them Allied artillery and bombs. The Seahawk's second chief function is search-rescue missions. On rescue missions a bunk can be arranged back of the pilot's seat, into which a man can crawl.

The propeller is a four-blade Curtiss unit, the blades of which are of hollow steel construction. The blades also feature the flanged-shank system of retention recently announced by the manufacturer's Propeller Division. This newly designed retention system is reported to be 15 per cent lighter than the old threaded type and is about 25 per cent stronger. Curtiss-Wright Corporation.

Sealing Compound

A synthetic resin, oil-base material for sealing joints and seams of floats and pontoons, and for coating or impregnating joint tape for water and airproofing, is being marketed to the aviation industry as No. 1780 Marine Batten Dolfinite. Possessing sealing quality and resistance to gas, water, and vibration, it is reported to be noncorrosive and to have no deterioriating effect on aluminum, aluminum alloy, stainless steel, or other alloy metals.

No. 1780 is of semiliquid consistency, slow setting, and can be brushed or forced into seams. It will withstand −60°F. and 200°F. temperatures without oozing or sagging, remaining tacky, flexible, and elastic. The Dolphin Paint and Varnish Company, Toledo, Ohio.

Fire-Resistant Upholstery Fabric

A fire-resistant, plastic-coated upholstery fabric, developed for aircraft, tanks, and ships, is expected to find wide postwar usage also in boats, restaurant seats, and office furniture. The fabric consists of a flameproofed cotton cloth base with a flexible fire-resistant surface coating of synthetic resin. The material will char in contact with a flame but will not support combustion. When the flame is withdrawn, there is no afterglow. The fabric is described as being so pliable that it will not crack in a flexing machine test at −30°F.

The biggest problem solved in meeting military needs for the material was to discover the proper combinations of fire-inhibitive softeners which would also impart good flexibility to the coating. Three so-called plasticizers are used. The material, known as P.C. "Cavalon" plastic-coated fabric, will be available in a range of colors, grains, and finishes when war demands are met. E. I. du Pont de Nemours & Company, Inc.

Nonlinear Potentiometer

A new nonlinear wire-wound potentiometer is claimed to have the highest degree of operating accuracy of any similar instrument. While its accuracy depends, of course, on the shape of the desired curve of resistance versus rotation, the maximum actual error in reproducing the desired curve with this potentiometer is said to be far less on each particular job than ever before attained, reaching consistent tolerances of $\frac{1}{2}$ per cent or better for certain curves. The higher accuracies are accomplished through new principles in design and precision manufacture.

Features of the new variable resistor include great flexibility for reproducing any desired curve within certain limits; small size; long life with sustained accuracy; and ability to replace more costly alternative circuits and components.

It is suggested that replacement of linear potentiometers with the nonlinear device would reduce expenses through elimination of eccentric gears. This replacement would make possible the use of uniform scales and give greater accuracy by removing backlash.

The new potentiometer was developed for use in bridge T attenuators in an airborne electronic computing gun sight. At present, it is produced in standard size with a $1\frac{7}{8}$-in. outside diameter, but additional sizes are planned. The current model can be used singly or stacked to as many as 18 on one shaft. Linear units also are available. Fairchild Camera and Instrument Corporation.

New French Transport Plane

The Bloch 161 is entirely metal plated, with underslung wings having a span of 98 ft. It has a cruising speed of 270 m.p.h. at 7,500 ft., and can climb to a height of 25,000 ft. It is powered by four Gnome and Rhone engines. Flown by a crew of five, this transport plane is expected to be useful for both wartime and peacetime needs. It can carry 60 seated men, 18 wounded men in berths, or 45 fully equipped paratroopers. As an air liner it can carry a load of 33 passengers and one ton of luggage or freight for a nonstop flight of 550 miles. French Air Ministry.

Current Recorder for Resistance-Welding Electrodes

A new current-force recorder for recording current and force in resistance-welding machine electrodes is designed for use in welding research and for the periodic checking of welding machine performance. The new recorder is intended to be helpful to users of energy-storage type welding machines for determining when forge pressure is applied to the work with respect to the discharge of welding current. In addition, the recorder permits resistance-welding machine users to comply with Navy Specifications, Navaer PW-6A, Bureau of Aeronautics, Specifications for the Spot Welding of Aluminum Alloy, for Class A Spot Welding.

The recorder consists of an amplifier-oscillograph unit and a special electrode holder. The amplifier-oscillograph unit, which operates from a 115-volt, single-phase, 60-cycle power source, is composed of a single-channel amplifier, an oscillator, a power unit, and a small magnetic oscillograph, all housed in a metal case. This unit simultaneously records a timing wave, the rapidly changing electrode force, and the electrode current of the welding machine while a weld is being made. The record produced by the recorder also indicates squeeze time, the duration and magnitude of the welding current, the rate of rise of forge pressure, and the hold time.

The special electrode holder is equipped with strain gages for measuring compressive strain, which is a measure of the force in the electrode, and a built-in shunt for diverting from the electrode a proportional amount of current, which is used to operate an oscillograph galvanometer.

In operation, a 5,000-cycle voltage from the oscillator is applied to two points on the strain-gage bridge circuit, and the output from the two opposite points is a measure of the force on the electrode. The output of the bridge is fed into the amplifier, which amplifies the modulated carrier and rectifies and filters the amplified output. The output is then fed to the oscillograph, where the record is made. The welding current and a 60-cycle timing wave are re-

OPPORTUNITIES FOR
ENGINEERS AND DRAFTSMEN

Pratt & Whitney Aircraft, in maintaining leadership in the expanding aircraft power plant field, requires qualified persons, preferably younger men, to participate and grow with its expanding engineering program on gas turbines and internal combustion engines.

DEVELOPMENT ENGINEERS

Mechanical and Aeronautical
(Civil and Electrical Engineers with related experience may also qualify.)

For engineering activities relating to the design, development and production of all types of aircraft power plants.

DESIGNERS

To make original designs of power plant mechanisms, assemblies and to work out variations or improvements in current designs.

DESIGN ANALYSTS AND CHECKERS

To analyze layout and detail drawings of aircraft power plants for accuracy of detail, calculations, material lists and specifications; investigate drawings to insure completeness of information from the manufacturing, tooling and inspection standpoint.

DRAFTSMEN

To prepare layout, assembly drawings or detail drawings for new designs or design changes for aircraft power plants following specifications, general instructions or sketches.

EXPERIENCE WITH AIRCRAFT ENGINES DESIRABLE BUT NOT REQUIRED.

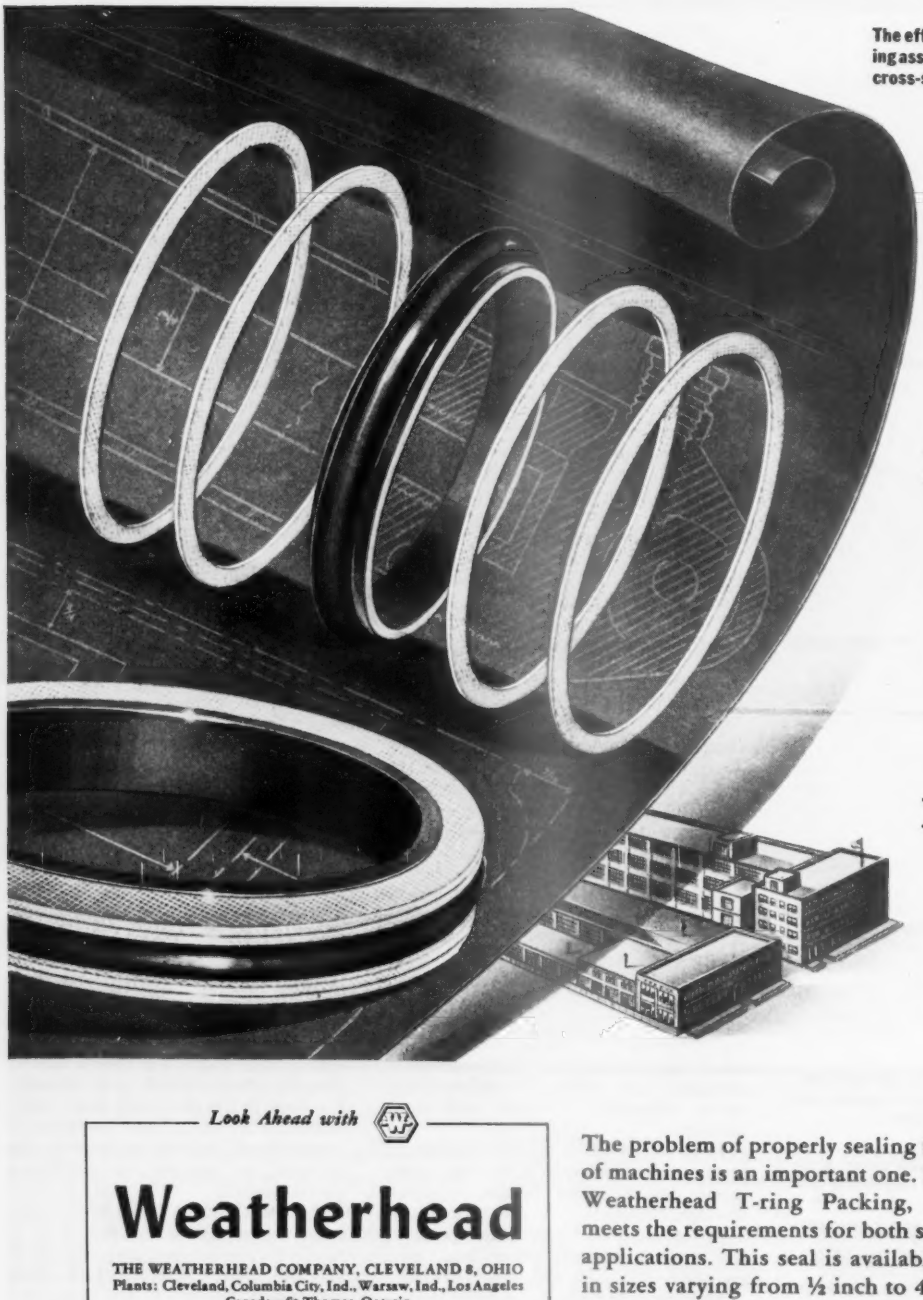
Address letters to Engineering Department stating age, marital status, details of education, experience and draft classification.

PRATT & WHITNEY AIRCRAFT

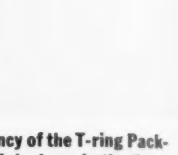
East Hartford 8, Connecticut

Applicants must conform with war manpower commission regulations.

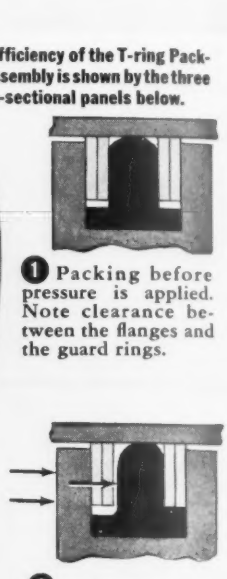
Improved WEATHERHEAD T-RING PACKING



The efficiency of the T-ring Packing assembly is shown by the three cross-sectional panels below.



1 Packing before pressure is applied. Note clearance between the flanges and the guard rings.



2 Packing upon immediate application of pressure which swells the flange under the farther guard ring and against cylinder wall.

3 Full application of pressure. Guard rings are held tightly against cylinder wall — no binding or jamming.

Look Ahead with AW

Weatherhead

THE WEATHERHEAD COMPANY, CLEVELAND 8, OHIO
Plants: Cleveland, Columbia City, Ind., Warsaw, Ind., Los Angeles
Canada — St. Thomas, Ontario

The problem of properly sealing fluids in many types of machines is an important one. The new, improved Weatherhead T-ring Packing, recently patented, meets the requirements for both standard and special applications. This seal is available in two types and in sizes varying from ½ inch to 4 inch O. D. For information or literature write or phone any Weatherhead branch office.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • DETROIT • CHICAGO • ST. LOUIS • LOS ANGELES

corded simultaneously on the $3^1/_2$-in. paper record. General Electric Company.

Graphite-Base Lubricant for Spark Plugs

A graphite-base lubricant is credited with eliminating spark-plug seizing and thread-galling in engines using high octane fuel. It has been approved by the Air Technical Service Command of the Army Air Forces for use on spark plugs in all B-24 type airplanes. Now identified as Mobilgrease Aero SP, the lubricant is easy to apply and can be spread smoothly over the surface of the threads of both the adapter and the spark plug. It is reported that after a run-up test it was discovered that the remaining film of this new graphite-base lubricant was more evenly distributed over the entire thread surface, whereas the mica-base compound previously used had accumulated at the thread base and became so dry and caked that even specially designed torque wrenches would not loosen them. General Petroleum Corporation.

Bellows for Various Uses

Designed to the customer's specifications, Autoflight bellows are made from stainless steel, phosphor bronze, beryllium copper, brass, or special alloys.

These units, made in many sizes, are used as temperature-regulator elements converting pressure effects into controlled movement, as pressure and shaft seals, as mechanical actuators, and as volume-expansion compensators.

Complete control units, such as pressure switches incorporating Autoflight bellows, are also available on short notice. G. M. Giannini & Company, Inc., Autoflight Division, Pasadena, Calif.

Moisture-Resistant Packaging Material

A new packaging material for the moisture protection of airplane engines and replacement parts utilizes aluminum foil and a film with a plastic base. Designated as Metalam No. 140, the material consists of aluminum foil laminated on both sides with Vitafilm, which is produced from a vinyl resin. The aluminum foil increases the moisture resistance of Vitafilm.

Metalam 140 is said to be easily and quickly sealed with heat. It is credited with protecting engines and replacement parts for as long as 9 months when coupled with the moisture-absorbent properties of silica gel. The Goodyear Tire & Rubber Company.

Tire-Testing Machine

One of the world's largest tire-testing machines will be used to conduct deflection and other tests on large pneumatic tires for airplanes and earth-moving equipment. Designed specifically for tires upon which pressure can be exerted up to 600,000 lbs. when necessary, the machine can also be employed for any type of tensile or compression work within its dimension and load-capacity limits.

Hydraulically operated and supplied with three load ranges, the machine has a clear width of 6 ft. between columns and will accommodate tires or other test specimens measuring up to 12 ft. in length or height. Power for operation of the machine is supplied by a motor for driving the screws and locating the height of the crossheads. The unit also has a smaller motor for developing hydraulic pressure for the loading cylinder.

Looking toward the future, the machine is expected to provide tests to determine deflection characteristics of any type or size of tire which can be foreseen at present. The Goodyear Tire & Rubber Company.

Air-Powered Pumping Unit

Model 132B-A air-powered pumping unit was designed specifically for use in handling aviation fuels and lubricants inside hangars where it was necessary to eliminate all possible fire hazards. The air motor is designed to eliminate the possibility of explosion or fire that is present where gasoline engine or electric motor power is used. It operates on 80 lbs. to 100 lbs. air pressure and requires 48 cu.ft. per min. at full throttle. Its capacity in aviation gasoline is 20 gal. per min.; aviation hydraulic oil, 15 gal. per min.; and aviation engine oil, 5 gal. per min.

The pump is of the rotary vane type, having $1^1/_4$-in. suction and discharge. The air motor is multivane, with a hardened steel rotor. It develops 1.4 hp. at 810 r.p.m. Harman Rotary Pump Company, Los Angeles.

New Electrode for Welding Cast Iron

"Harcast" is an all-position mild steel electrode for welding and repairing cast iron. It is said to fuse well with either mild or medium carbon steel, making it suitable for joining cast iron with other types of steel. With a yield point of 50,000 lbs. per sq.in., the deposited metal has an ultimate tensile strength of 60,000 lbs., roughly double that of a good grade of cast iron.

Usable with either a.c. or d.c. machines (straight or reverse polarity on d.c.), Harcast works well at low amperage, thus minimizing the dilution effect at the fusion zone and permitting a higher quality of machining. Reverse polarity on direct current produces a smooth bead with deep penetration. On d.c. straight polarity, penetration is less, higher beads are built, and there is less spread in the fusion zone. In either case—as with a.c.—Harcast is credited with assuring a sound, deep weld for any good grade of cast iron. Harnischfeger Corporation, Welding Division, Milwaukee.

Air Switch and Flight-Hour Meter

Automatic recording of actual flying time of any aircraft is the function of the Hobbs flight-hour meter and air switch. The meter is quite similar to the manufacturer's engine-hour meter, which is used to indicate hours of engine operation. It has three hands, one making a complete revolution in 10 hours, the second in 100 hours, and the third in 1,000 hours.

The meter can be mounted on the instrument panel or placed out of sight of the operator if desirable. Its operation is automatically controlled by the Hobbs air switch which is mounted on the inspection plate on the wing and is actuated by the air pressure developed when the plane, at take-off, reaches a speed of approximately 40 m.p.h. Contact is maintained while in flight. When landing, and speed reduced to less than 40 m.p.h., the switch automatically goes to "off" position.

The Hobbs flight-hour meter is made for 6, 12, or 24 volts, d.c. It measures approximately $2^7/_8$ in. by $2^1/_2$ in. and weighs 8 oz. John W. Hobbs Corporation, Springfield, Ill.

The Howe Scale Company's special cargo scale.

Cargo Scale Light Enough to Carry Aboard Airplanes

A special cargo scale having a capacity of 5,000 lbs., weighs 185 lbs. It has been so designed that it can be carried aboard planes for use at poorly equipped airports. The result was accomplished through compact design and the use of heat-treated aluminum for all of the castings. Two beams are provided on the scale, the lower of which is graduated in units of 2 lbs. The platform measures 24 by 36 in.

The manufacturer also produces special and standard aircraft scales for weighing complete planes, for wing and tail weighing, propeller balancing, measuring oil and fuel consumption, engine testing, production control, and the counting and weighing of parts. The Howe Scale Company, Rutland, Vt.

Comments on Broaching in Aircraft Production

A lengthy discussion of the broaching process is given in a 16-page loose-

New Alloy Adds Thousands of Miles to Valve Life!

THE consistent increase in power output of modern aircraft, marine, and automotive engines — involving higher temperatures and greater stresses—has been a constant challenge to the metallurgist to develop valve materials which would deliver satisfactory performance under increasingly severe operating conditions. As a result, valve development has not only held its own with ever more exacting engine requirements, but it has actually doubled and tripled the normal life span of engine valves.

With this announcement The Eaton Manufacturing Company makes an important addition to its long list of contributions to improved valve performance. Many of these contributions have been basic "firsts" in valve design, metallurgy, and manufacturing methods.

Eatonite is a heat-resistant, corrosion-resistant, and wear-resistant alloy which is readily applied to valve faces by conventional welding methods. In extensive comparison tests conducted both in the laboratory and in the field, valves and valve seat inserts faced with Eatonite have invariably shown marked superiority. In addition to its remarkable physical properties, Eatonite comes well within practical limits from the standpoint of cost, adaptability, and ease of application.

Eatonite has already made a distinguished contribution to the efficiency and life of power plants in military aircraft, ships, and combat vehicles; it is destined to influence the whole aspect of valve life and efficiency in the engines of tomorrow.

EATON

EATON MANUFACTURING COMPANY
General Offices: Cleveland, Ohio

Plants: Cleveland, Detroit, Saginaw, Marshall, Battle Creek, Lawton, Vassar, Massillon, Windsor (Canada)

SUPPLIERS OF FINE PRECISION PARTS TO THE AUTOMOTIVE AND AIRCRAFT INDUSTRIES FOR MORE THAN THIRTY YEARS

leaf treatise outlining the history of the process, specific examples of it in war production, and the use of broaching in postwar production. The writer reviews the development of broaching tools, machines, and techniques, and gives numerous examples of the solution of difficult problems through the use of the method. Among the examples are several instances involving the application of broaching in the production of intricate aircraft parts. The Lapointe Machine Tool Company, Hudson, Mass., and Edgware, Middlesex, England.

Electrical Actuators on Thunderbolt Dive Flaps Overcome Air Compressibility

The dive-flap installation on the P-47 Thunderbolt includes two Lear Rotary Actuators that are connected to the flaps by means of levers and rods, flexible shafting, angle drives, bulkhead connectors, limit switches to control the extent of travel of the dive flap, a relay, and a circuit protector, connected with the switch in the cockpit. There is a Lear 206B actuator in each wing. The actuators are interconnected by flexible shafting, through angle drives and couplings. This interconnection provides synchronization and emergency power so that in case one actuator motor is damaged by gunfire the other can drive both flaps.

The Series 206B Rotary Actuator that powers these dive flaps is designed for heavy-duty loads up to 650 lbs.-in. with a normal load of 250 lbs.-in. It operates at 26 r.p.m. It is powered by the "D" frame Lear motor, and the Lear Fastop clutch, which is standard equipment on this actuator, provides accurate positioning. The complete power unit weighs less than 8 lbs. Lear Incorporated, Piqua, Ohio.

Lockheed P-38 Lightning Pathfinder

The Pathfinder is a modified Lockheed Lightning fighter that carries equipment stated to be so effective that Lightning fighter-bomber sorties have been able to wipe out invisible enemy targets.

The Pathfinder's elongated metal and plastic pilot's nacelle is cylindric and blunt. It has instruments that are advanced over those of the earlier "droop-snoot" Lightning which contained all the standard bombing and navigational equipment of a heavy bomber.

Like the "droop-snoot," the new craft is a two-man airplane. In addition to the pilot, the plane carries a bombing operator in its specially constructed nose. It carries 4,000 lbs. of bombs on underwing shackles. Lightning "bombers" are also fitted for effective strafing after bombs have been directed to the target.

The four 50-cal. machine guns and one 20-mm. cannon located in the nose have a concentrated fire power capable of sinking warships. The Pathfinder was developed at the manufacturer's Dallas Modification Center. Lockheed Aircraft Corporation.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Turret Drill Head with Indexing Depth Stop

Model No. 275, one of three new six-spindle turret attachments for drill presses, features a type of indexing depth stop designed to control the drilling depth of each of the six spindles of the turret head. The depth-stop mechanism, which is completely enclosed, comprises a cylindric drum carrying six adjustable stops that are easily positioned through an opening in its aluminum-alloy housing. The drum is geared to the turret head and automatically indexes when the turret head is turned. Thus an adjustable stop is brought into control position when its corresponding turret spindle is indexed to operating position. No. 1 Morse Taper precision-ground spindles are another feature of this new turret head. The spindles are of one-piece construction, hardened and ground to a precision of 0.0002 in.

Two other improved models also are available for immediate delivery. These units are Model Nos. 274 and 273. Model 274 is identical to Model 275 but is not equipped with the indexing depth stop. Model 273 is also identical to Model 275 except that it is provided with solid, one-piece, precision-ground spindles having either No. 2 or No. 33 Jacobs Tapers to fit corresponding Jacobs chucks, instead of the No. 1 Morse Taper spindles, and it is not equipped with the indexing depth stop. These turret heads are designed to fit practically all types of medium-sized drill presses having quill diameters from $1^3/_4$ in. to $2^3/_8$ in. Madco Products, Inc., New York.

Gages for Adjusting Throttle Systems

A simple method for adjusting the throttle systems from the pedestal to the engines in airplanes has been made possible through the use of a series of new gages. They have proved particularly valuable in simplifying maintenance work on planes in the field when a carburetor change proved necessary.

The new tools are small, calibrated gages, one for each carburetor, and an additional one for the engine-throttle control levers in the cockpit. In the case of Martin Marauders, the set for field work consists of one for each of two carburetors and one for the control lever. They are calibrated to synchronize both engines at idling speed, at 1,000 r.p.m. and 1,900 r.p.m.; and at 40° and 50° manifold pressure, which are the important operating settings for the type of engines used in the Marauders.

The tools are simple to use. The throttle levers are locked at one of the desired check points as marked on the pedestal gage. Then the rods and cables are adjusted to the comparable setting on the gage at the carburetor. This results in a standard setup for all planes of a single type and makes it relatively easy to adjust the throttle system at any time a test or check is necessary.

The new tools have proved particularly valuable as test timesavers, since engines now can be synchronized in approximately 30 min. Before they were put into use, the work took from one-half to 3 days to complete. In addition, the new gages eliminate all guesswork on the part of the mechanics when adjustments are made. The Glenn L. Martin Company.

Photographic Measurement of Take-Off Distance

An "error-proof" photographic method to measure take-offs and landings of airplanes is based on a "camera-enclosed grid" exposed on motion-picture film.

The motion-picture procedure was adopted because the successive frames of the film could be arranged in various forms and studied for the measurements of distances traveled by the plane. The mechanical recordings of the camera were found to be far more accurate than those of several individual observers with theodolites. From a careful check of problems in the older methods, it was concluded that a "camera-enclosed grid" was the only practical solution. After considerable experimental work with many kinds of equipment, the inventors found a simple method whereby the film was double exposed, first to a specially prepared grid, then to the airplane moving along the runway.

To obtain the grid, a sheet of glass was coated with an opaque substance, and vertical and horizontal parallel lines evenly spaced were scribed through the opaque coating with a sharp instrument. Placed before an even source of light and photographed, a grid composed of white lines resulted on the positive film. The film was not developed after exposure to the grid but was rewound and used in the camera for a second time so as to superimpose the picture of the moving airplane on the grid.

The camera, fitted with a wide-angle lens, was loaded with the grid-marked film and set up to remain stationary at a predetermined distance not less than 500 ft. from, and at right angles to, the runway on which the airplane was operating. Arranged in the field of the lens, close to the edge of, and parallel to, the length of the runway, two or more markers or flags were set up at intervals of 100 ft., in front of the camera. As the airplane, moving along the runway for take-off, approached the field of the

This advertisement is one of a series now appearing in national magazines and newspapers as Consolidated Vultee's contribution toward a clearer public understanding of how and why America must retain its present Air Supremacy, even after Victory.

THE JOKER IN AIR POWER

EVERY PILOT who wings his Liberator or Fortress over Germany or Japan knows what the joker in Air Power is.

Every ground crewman whose job is to keep a Mustang, Thunderbolt, or Corsair in hair-trigger fighting trim knows what it is.

Every aircraft engineer who ever saw the inside of a wind tunnel knows what it is.

Do you know the joker in Air Power?

It's very important that you should. **For, partly because America forgot it during the prewar years, we came terribly close to losing this war right at the start.**

But now we are winning the war, largely because a few far-sighted men knew what the joker in Air Power was.

So simple—so easy to forget

The joker in Air Power is TIME—the heart-breaking months and years it takes to design, to build, and to perfect a plane to the point where it becomes an efficient, service-tested battle plane, ready for action.

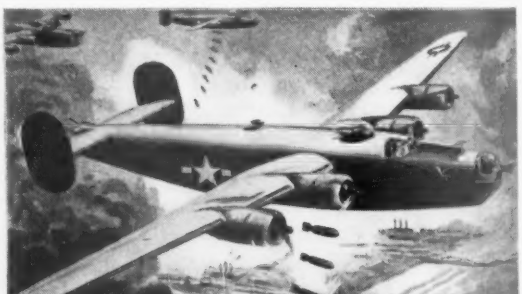
For example, America's first four-engine, long-range bomber was born back in 1934.

But when war was declared, some 7 years later, this bomber was not *even then* ready to go into action as the potent fighting weapon it is today.

True, the first model was flown in the summer of 1935. The aircraft engineers knew then that the basic design was good.

But between the first "prototype" and the current model, **there have been more than 4000 changes, involving over 4 million engineering hours.**

Even by working with desperate speed, it has taken years to smooth out the "bugs"—to give our Air Forces this heavy long-range bomber, so urgently needed, in its most efficient form.



There aren't many short cuts

When the war clouds grew blacker over Europe, the U. S. Army Air Forces came to Consolidated Vultee with the request for still another four-engine heavy bomber.

Shortly afterward—in 1939—the B-24 Liberator was born.

But, even with Consolidated Vultee's long experience in building mammoth sea planes, **it took over 3 years, over 1 million engineering hours, and more than 5 million hours to tool up the plants,** before the Liberator was ready to go into action as one of America's most devastating, heavy bombardment weapons.

Similarly, it took 5 years to develop one of this war's foremost fighter planes from drawing board to final test flight and mass production.

And one of the country's greatest aircraft engines has taken

11 years to develop—and ever since the war started, it's been undergoing change after change to increase its horsepower still more.

America 1941—a second-rate power

Many other examples could be cited. But there is no need to labor the point.

The truth of the matter is that America was caught napping. The nation which invented the airplane was woefully unprepared to defend itself against Axis air power. **We had become a second-rate power in the air.**

And the Axis knew it. They knew that under normal conditions, it takes from 3 to 7 years for a plane to progress from drawing board to combat duty.

What they overlooked was the undreamed-of capacity of the American people, and the American aircraft industry, to do the impossible.

Starting almost from scratch, we have been able to design, build, and deliver war planes by the tens of thousands—an air armada overwhelming in its might and superiority, *as of today.* But remember, the elapsed time has been *five years!*

"Hot" today—obsolete tomorrow

But in aerial warfare, the nation that depends on mere quantity and present-day superiority of its planes cannot win. That is one reason why Germany lost the Battle of Britain in 1940.

Progress in aeronautics is now so rapid that today's "hottest" combat plane is virtually obsolete tomorrow. Its quality must constantly be improved—to keep it superior to the enemy's ever-improving planes.

And it must be replaced, with all possible speed, by new planes now on our drafting boards, in our wind tunnels, or undergoing their test flights.

These are facts which an alert America should not, *must* not forget.

Another fact to keep in mind

If we are attacked again, there will probably be no warning whatever—**no time to prepare.**

There will be no other nation to hold off the enemy, as Britain did this time, while we frantically build up our power in the air.

And the attack will most certainly be made with new and even more terrible airborne weapons.

We must be ready, and able, to protect ourselves from such attack.

Air Supremacy alone cannot win a war, and may not in itself prevent *another* war. **But as long as we maintain our strength in the air, no aggressor nation in its right mind will dare think of attacking us.**

Air Power is Peace Power

The backbone of Air Supremacy is a strong, independent competitive aircraft industry, constantly working in research, in the improvement of production technique, and in the development of still finer planes.

But we must understand that Air Power is a combination of *all these things:* a postwar Air Force, commercial air transport, a strong supporting aircraft industry with permanent facilities to meet any emergency, widespread personal flying, and a national air-minded way of thinking.

When we understand this, we begin to realize that Air Power can be one of America's soundest investments in the interests of a lasting peace.

LET'S KEEP AMERICA STRONG IN THE AIR!

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

San Diego, Calif. · Vultee Field, Calif. · Fairfield, Calif. · Tucson, Ariz. · Fort Worth, Texas · New Orleans, La. · Nashville, Tenn. · Louisville, Ky. · Wayne, Mich. · Dearborn, Mich. · Allentown, Pa. · Elizabeth City, N.C. · Miami, Fla.

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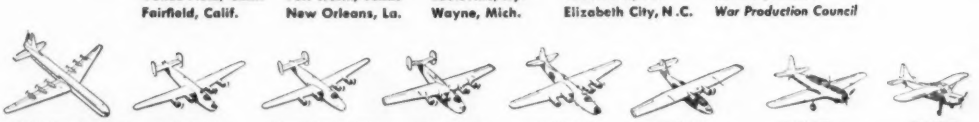

CONVAIR MODEL 37 *Pan American Clipper* · LIBERATOR *4-engine bomber* · LIBERATOR EXPRESS *transport* · CORONADO *patrol bomber* · PRIVATEER *search plane* · CATALINA *patrol bomber* · VALIANT *basic trainer* · SENTINEL *"Flying Jeep"*

HERE'S TOPS IN FLEXIBLE CORDS

IT'S DRAGGED over rough concrete, through metal shavings, grease, and water. It's coiled, twisted, and stepped on. But this tough, flexible cord stands the gaff. It's a Whitney Blake portable tool cord—approved by Underwriters Laboratories, and protected with VINYLITE plastic insulation!

The dielectric strength of this modern insulation permits the small diameter construction important to many instrument applications. And VINYLITE plastic wire and cable insulation has remarkable resistance to abrasion and impact, oils, grease, alkalies, most acids, and the aging action of air and sunlight. Some types are non-flammable, others slow-burning. All remain flexible at low temperatures. Thin-wall construction permits a greater number of circuits in existing conduits — and VINYLITE plastic insulation can be made in colors for quick identification.

VINYLITE plastic insulation is bringing widespread improvements to the makers of electric and electronic equipment, public utilities, construction concerns, and manufacturers of marine, automotive, and airplane products. Adopt it for your own requirements. Write for booklet 12-VR, "VINYLITE Plastics for Wire and Cable Insulation." It's yours for the asking.

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Vinylite Plastics

TRADE-MARK

lens, the camera was started. The film, having been double exposed, was then developed.

Because the camera operated at a fixed speed, and because of the known distance from the camera to the flags and between the flags, it was an easy matter to determine the vertical and horizontal distance represented by each grid space. By selecting a series of evenly spaced frames of the film, a graph representing the path of the airplane was drawn, from which could be determined the height of the airplane at any given distance from its starting point. The same procedure has been followed for recording landings. The Glenn L. Martin Company.

Improved Mareng-Cell Hanger Fittings

Another step toward the "ease of maintenance" goal in plane design and production has been made with the substitution of Rivnuts for rivets in attaching Mareng-cell hanger fittings to JRM Mars fire walls. The change eliminates difficulty in replacement of hangers damaged in service. Made of aluminum-alloy forging, the hanger fitting consists of a circular mounting flange with four holes for attaching it to the fire wall, and a threaded cylindric section that protrudes through an opening into the Mareng cell.

Operating and maintenance experience on other planes made the use of the Rivnuts advisable in the JRM installation, because the necessary removal of the Mareng cells for inspection and repair during periodic power-plane check-ups sometimes damaged the hangers. They are especially vulnerable because of the many threads that are subjected to damage or crossing from wrench slippage.

The fire-wall assembly is composed of two outside flat aluminum sheets with a reinforcing corrugation between. If the hanger, which was attached with four rivets, should be damaged it would present a real problem to the repairmen for it would mean working in a blind spot. Although the original rivets could be bucked without any difficulty during the construction of the assembly, they became blind after the last or outside sheet was assembled.

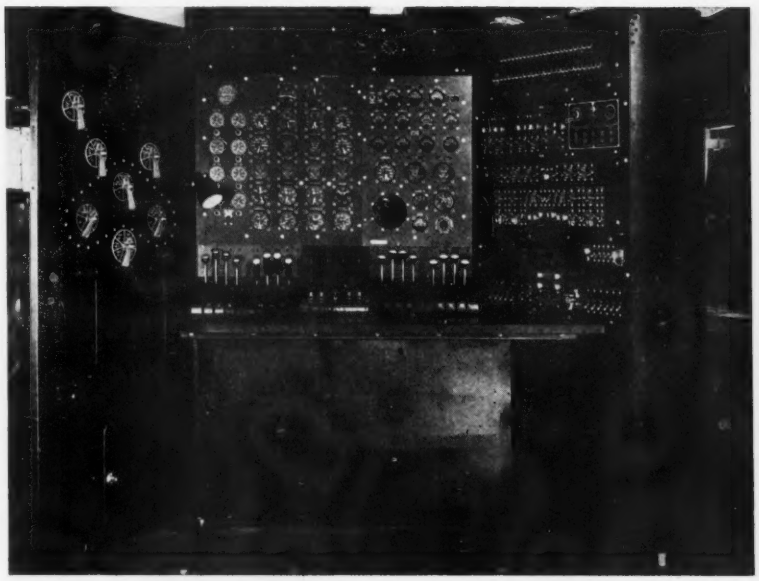
Before the change to Rivnuts, the only alternative was to drill out the original rivets and re-attach the new part with blind rivets. To use these in replacement would effect a satisfactory repair, but this also meant that the same time-consuming procedure would be necessary each time the replacement was made. Using the Rivnuts when the original installation is made eliminates the replacement problem. The Glenn L. Martin Company.

Improved Stencil-Marking Method

An identifying stencil job on tubing and bar stock, formerly done by 40 employees, is now being completed in less time by four people, by the use of a new stencil holder. Formerly the identification process required that the serial numbers and letters be painted by hand with a fine artist's brush on each piece of material. This method was slow and was subject to frequent errors.

Utilizing the new stencil, the bar stock or tubing is placed on a conveyer where it passes under a paint sprayer that stripes it full length with the proper identifying color. The material then moves on to the actual stenciling operation where the operator uses the new holder to mark the material. Linen stencils are used in preference to the more common paper stencils because they wrap more securely around the stock and do not smear so easily as the paper when the stencil is removed.

The holder is rectangular in shape, with an open top and the stencil forms the bottom of the "box." The linen is suspended by springs from small flanges at the top edge of the holder. When the holder is pushed down over the top surface of the stock it wraps itself tightly. After spraying the stencil from the open top, the holder is lifted and the springs pull the linen off the stock, which results in a perfectly stenciled number with no smearing. Since the new holder has been in use it has saved thousands of hours of valuable production time and has eliminated tedious hand labor. The Glenn L. Martin Company.



The flight engineer's panel of a Martin JRM Mars.

Installing Flight Engineer's Panel

Designers and engineers have found an easy way to accomplish the installation of the flight engineer's panel on the 85-ton JRM Mars type of aircraft for the U.S. Navy.

The panel board is composed of a center and two side-wing sections, with the fuel-system controls and water separators at the left, the operational master switch panel at the right, and the center section containing the 31 gages and meters of various types which make up the instrument panel and engine and propeller controls. All of the installation work on this equipment must be meticulous.

Accomplishing this task properly under the generally accepted method of constructing small subassemblies, taking them into the flight deck, fitting them together and then attaching the wiring, proved painstakingly slow. By the new method, individuals working on the panels have easy access to the mechanisms and precision is improved.

When a panel is completed and tested it is taken alongside the "ways" on which the JRM hulls are being built and placed onto a hoisting rack attached to an overhead crane. Before the "crown" or top section of the flight deck is put into place it is hoisted high in the air and lowered right onto the deck, where it is braced to the structural ribs. Final installation is easy. As each one of the 2,200 wires is numbered, it is necessary only to match the ends of the wires built into the craft with the corresponding duplicate numbers, and the flight engineer can go on duty. The Glenn L. Martin Company.

Gear-Tooth Spacing Checker

Model No. 1130 gear checker, specifically designed for the rapid, accurate checking of tooth spacing on gears, has been added to the maker's Sine Line checking equipment. The machine checks the base pitch and tooth spacing along the line of action on spur or helical gears. Spacing can also be checked on worm gears. Gears up to 12 in. outside diameter and having a maximum shaft length of 18 in. may be checked.

The principle of operation of this machine is based on the fact that the distance between the two corresponding sides of adjacent teeth along the line of action is equal to the distance between

To the grown-up boy who used to dream of owning a plane..

This "Propeller with a Brain" brings performance beyond the prewar hopes of private flyers

That's right! Aeromatic—*the one and only self-acting variable pitch propeller*—will make that postwar plane of yours perform "like a dream." It will let you takeoff with one-fourth shorter run. Increase your rate of climb one-third. Give you greater cruising range and speed. And yet keep fuel consumption and engine wear down to a minimum. What's more, with Aeromatic you'll get long glides for happy landings—with an instantaneous change of pitch for a quick pickup if you overshoot the landing strip or field.

Completely self-contained and self-acting, the Aeromatic Propeller lets your plane and engine deliver automatically, as no other propeller can, *all* the performance that is built into them. Without instruments or controls—with nothing extra for you to watch or do—it automatically assumes the correct pitch for peak efficiency under all flight conditions. There's nothing else like it.

If you fly, or plan to fly, you will want an Aeromatic Propeller on your plane. Write to your aircraft manufacturer about it today. And if you'd like our little get-acquainted folder, containing a diagram of the "brain" in an Aeromatic, drop a line to Aeromatic, 302 Scott St., Baltimore 3, Md. We'll be glad to hear from you.

The Propeller with a Brain for Tomorrow's Plane

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Air Controlled *Automatic Propeller*

KOPPERS COMPANY, Inc., BARTLETT-HAYWARD DIVISION

Licensed under patents of EVEREL Propeller Corporation

corresponding sides of adjacent teeth measured on the gear's base pitch circle. The new machine measures along the line of action, indicating whether the spacing is correct both along the line of action and along the base pitch circle of the gear. Michigan Tool Company, Detroit.

Electronic Gasoline Gage

The Liquid Level Indicator is a gasoline gage so accurate in operation as to obviate the need for carrying extra fuel to make sure of a sufficient supply to complete a flight.

Developed at the request of the Air Technical Service Command, Wright Field, Dayton, Ohio, the device is reported to be accurate within 5 per cent under extreme conditions of temperature, altitude, and plane attitude. This, it is stated, compares with at least 15 per cent error in earlier means of aircraft-fuel measurement. With no moving parts, bellows, gears, cams, or levers to get out of calibration, the Liquid Level Indicator weighs slightly more than present fuel-measuring systems and operates from an infinitesimal electric current which is passed through the gasoline tanks.

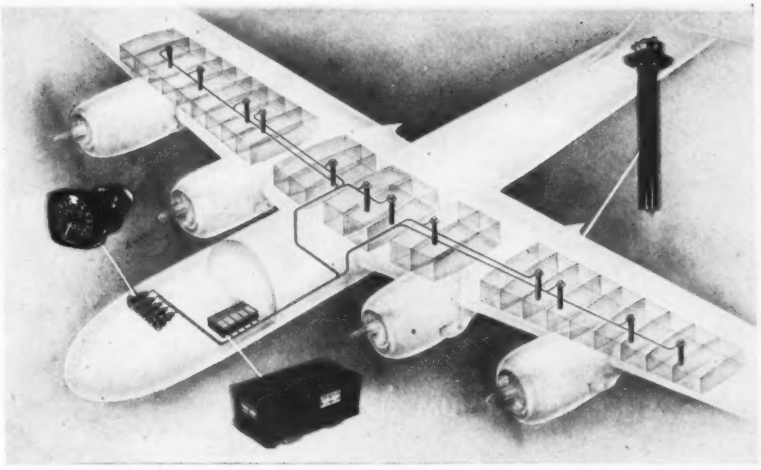
The problem of determining fuel supplies involves numerous factors. First, gasoline shrinks in volume with a drop in temperature. From ground level to 25,000 ft. this shrinkage frequently reaches 10 per cent. Secondly, because main supply tanks are located in the wings, the level constantly changes with the rolling or pitching axis of the plane, giving false readings on conventional gages of as much as 20 per cent error. Fluctuations caused by motion or temperature are further amplified because at the low pressures encountered at high altitudes the fuel boils, causing a foam to form on the surface of the gasoline and the float rides on top of the bubbles, thus indicating a still greater supply.

These factors were overcome by an electronic capacity type indicator that would measure gasoline by weight, be unaffected by temperature, and would compensate for the tilt of the wings by multiple pickup points.

The instrument consists of a long tube that is mounted within the tank, and an electronic amplifier and meter mounted in the fuselage. The tube is actually an electrical condenser. Called the "tank unit," the tube is construc ted so that gasoline can flow inside it and between the two inside pipes. A minute electric current moves from one of these tubes through the gasoline to the other tube. The electrical capacitance of the gasoline, which changes with the height of the liquid within the tank unit, is measured electronically by the amplifier and a signal is sent to the indicating dial on the plane's instrument panel. Minneapolis-Honeywell Regulator Company.

Gasoline Gages

A line of gasoline gages is designed for every type of installation required for light aircraft. These gasoline gages are of the direct-reading type and are moderate in cost. Shielded magnetic transmission is intended to give positive vapor and moistureproof seal. In addition to a gear-type dial gage, Model A-21, there are available a spiral-type dial gage, Model A-22, and a gear type with drum gage, Model A22-D. Scott Aviation Corporation, Lancaster, N.Y.



A typical Minneapolis-Honeywell gasoline gage installation in a hypothetical four-engined airplane.

Parking-Brake Valve

Installed in the hydraulic line between each master cylinder and brake assembly, the new Scott Model 4200 parking-brake valve provides parking brakes for any aircraft equipped with hydraulic brakes. The valve is designed to seal in the pressure for a long period of time. The construction is simple, involving only two moving parts, and is intended to serve throughout the life of the airplane. Scott Aviation Corporation, Lancaster, N.Y.

Precision-Measuring Instrument

The new high-amplification five-tube Precisionaire is an example of the almost unlimited possibilities of air gaging. Five tubes, each capable of providing an amplification of 18,000 to 20,000 to 1, are combined in one instrument to check ten points along the $^1/_2$-in. diameter of a critical part. The tolerance at each point is ± 0.000005 in. Out-of-roundness, taper, and undersize or oversize conditions are disclosed. The part for which this application is designed mates with a part that is checked by a similar instrument.

The part is checked by placing it against the left side rail and rotating it through 180°, this operation simultaneously checking five points along the diameter. It is then placed against the right side rail and again rotated through 180°, which gives a simultaneous check of five different points along the diameter. Tungsten carbide locating pads at the bottom and both sides of the gaging slot serve to locate the masters and the work part.

Minimum and maximum fixed size masters are used to set up the Precisionaire. The centerline on the transparent slide is used as reference for this setting. With the maximum size master in gaging position, the orifices and air pressure in each tube are so regulated that all five floats are at the same horizontal line. The same method is used in setting the minimum master and a check is made to see if the five floats are in a straight line.

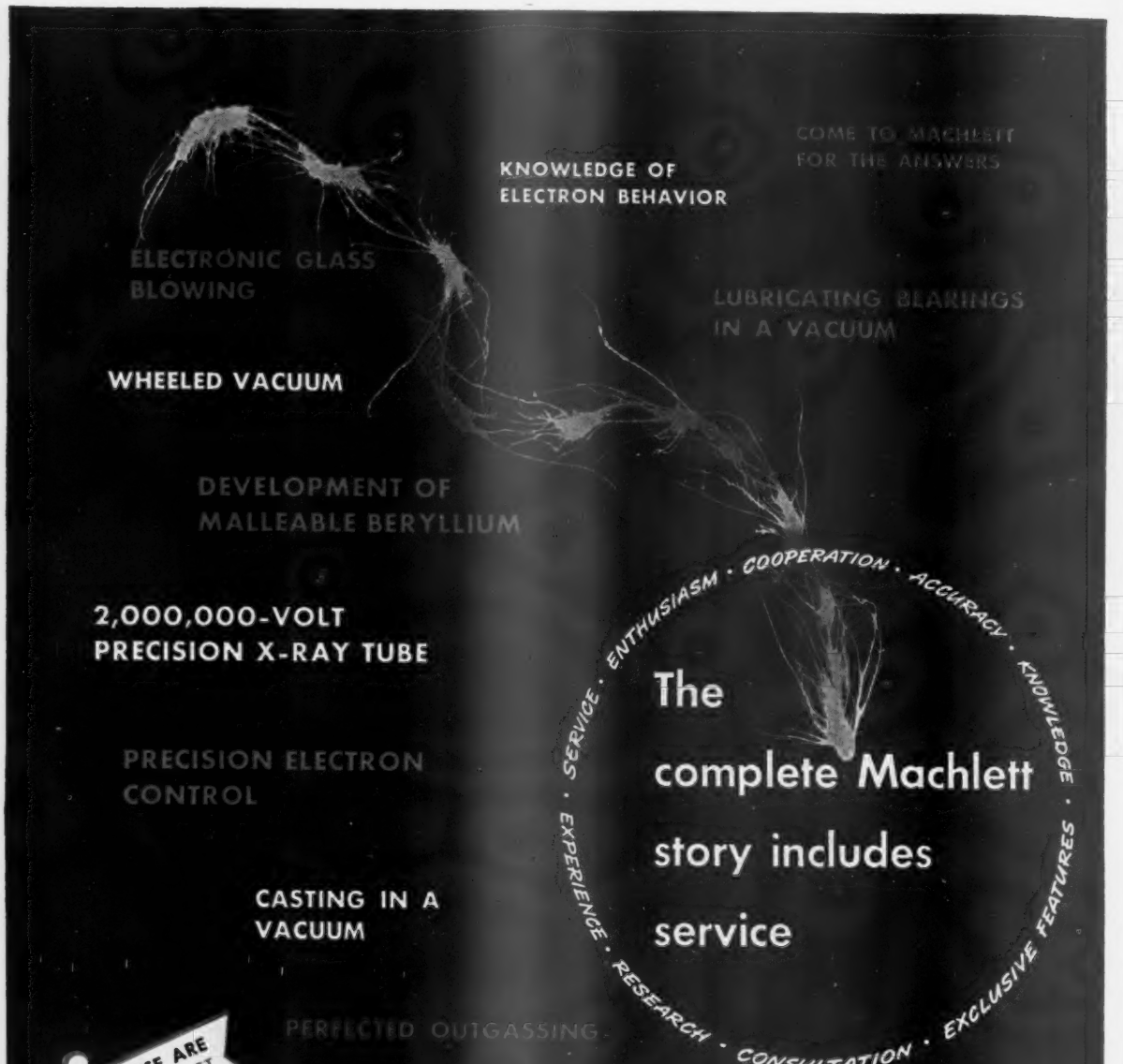
Maximum and minimum tolerance limits are indicated by lines on the transparent adjustable sight. The use of this sight in conjunction with the calibrated scale enables the operator to reject defective parts and to classify acceptable parts. The Sheffield Corporation, Dayton, Ohio.

The 14-Passenger Marathon

A new British four-engined high-wing monoplane has been designed to the requirements of the Brabazon Committee. Of all-metal construction, the Marathon is suitable for the carriage of 14 passengers and a half ton of luggage and freight over a distance of 750 miles at cruising speeds ranging between 175 and 200 m.p.h. Alternatively, the aircraft can be used as a freighter carrying a pay load of two tons.

Accommodation in this aircraft is said to be spacious. Air conditioning, controlled by the pilot, provides passengers with comfortable traveling conditions, and engine and propeller noise is eliminated in the cabin by scientific soundproofing. The aircraft may be pressurized to a differential of $2^1/_2$ lbs. per sq.in. if desired.

The span of the Marathon is 65 ft., its length 51 ft. 6 in., and its height 13 ft. 3 in. The volume of luggage and freight compartments is 350 cu.ft. and the width of passengers' seats between arm rests is 21 in. There is ample headroom for passengers, the height of the cabin in the aisle being 6 ft. 3 in. Its still air range is 750 miles and its maximum cruising speed at 7,000 ft. is 210 m.p.h., with the economical cruising



The above ten Machlett techniques reflect only a part of one side of this organization — that of technical capability.

It takes much more than even the highest techniques to make a business great. There is also required a thorough knowledge of customers' requirements, and that conscientious, painstaking, continuing meeting of them called "service."

Just as there is the most intimate relationship between an electron tube and the equipment with which it is connected, so there is a close and constant contact with our customers. With them we are never in competition, and thus we may be, and often are, called upon to do design and development work, to live with tube and equipment problems, and cooperate in solving them. We often follow through all the way to the ultimate users, to make certain of their satisfaction and see that conditions of use are such as to assure optimum results and economy. It is a long-established Machlett practice not merely to accept but to seek out every opportunity to serve. Thus, Machlett customers obtain much more than the best possible tubes.

When you need a medical or industrial X-ray tube, or a radio or industrial oscillator, amplifier or rectifier, it will pay you to choose a Machlett. Write for information as to available types, identifying the associated equipment and nature of use. Machlett Laboratories, Inc., Springdale, Connecticut.

MACHLETT
X-RAY TUBES SINCE 1897
TODAY THEIR LARGEST MAKER

speed 175 m.p.h. The initial rate of climb is 1,300 ft. per min. The Society of British Aircraft Constructors, Ltd.

New British Aircraft

Three new fighters, a new bomber, and a new cargo carrier have been revealed recently by the British aircraft industry. The five aircraft are the de Havilland Vampire, jet-propelled fighter; the de Havilland Hornet, twin-engined fighter; the Vickers-Armstrongs Spiteful, single-engined fighter; the Avro Lincoln, four-engined bomber; and the Miles Aerovan, twin-engined freight carrier.

Two of the new types, the Hornet and the Lincoln, are specifically designed to carry the air war into the Japanese homeland, with a fighter having the advantage of bomber range and a bomber said to be able to carry a bigger load than any other bomber in the world. The Vampire is stated to have been the first aircraft in the world to fly at more than 500 m.p.h. This new single-seater British fighter is jet propelled, powered by a single gas turbine engine. As this aircraft, like other new combat aircraft, may be used in the Far East war theater, no other details are to be disclosed at present.

From the same company as the Vampire comes the Hornet, twin-engined fighter with single-engine maneuverability. The top speed of the Hornet is estimated at more than 470 m.p.h. It is powered by two Rolls-Royce Merlin engines. The Hornet is smaller, faster, and "cleaner" than the de Havilland Mosquito, and is claimed to be the fastest propeller-driven aircraft in the world.

In the Spiteful, the Spitfire grows up to more than 460 m.p.h. It is a single-seater fighter, powered by a Rolls-Royce Griffon engine. Following the Spitfire, of which it is a development, and its naval version the Seafire, the Spiteful is designed for reliability, maneuverability, and deadliness in combat.

The fourth new type is in the bomber class—the Lincoln—a "big brother" of the Lancaster. The Lincoln is intended to carry the heaviest bombs over a range considerably in excess of that of the Lancaster and at a greater speed. It has four Rolls-Royce Merlin engines and will be manufactured in Great Britain by A. V. Roe and Company. It is also being manufactured in Canada and Australia.

Great Britain's newest civil air transport—the twin-engined Miles Aerovan, carries one ton of cargo a distance of 450 miles at a speed of 100 to 115 m.p.h. at a direct fuel-oil cost of only $3\frac{1}{2}d.$ per ton-mile. It takes off and lands with a run of no more than 100 to 260 yards (according to load). The Society of British Aircraft Constructors, Ltd.

Synthetic Rubber Forming Pad for Hydraulic Pressing of Magnesium Sheet

The production of magnesium sheet-metal parts for airplanes will be speeded up as the result o. the development of a new heat-resistant synthetic rubber forming pad.

The pad is a solid block of synthetic rubber weighing 2,800 lbs. and measuring 116 in. long, 50 in. wide, and 8 in. thick. It is used as the female die in hydraulic presses to form heated magnesium under 5,000 tons of pressure. When compressed, the rubber transmits the full pressure of the hydraulic ram against the sheet, flowing into all irregularities and forcing the metal into the desired shape. When the pressure is released the rubber returns to its original form.

Since the beginning of the war the manufacturer has made many rubber forming pads for the cold forming of aluminum. These pads were not suitable for shaping magnesium, however, because the magnesium tends to be brittle when cold and does not respond to forming without heating. This pad, the first one of its kind, will withstand temperatures up to 450°F. required by the process. In addition to being heat resistant, it is built to withstand severe flexing and long wear.

Instead of the usual set of mating dies used in hydraulic presses, this process calls for only one male die. The mating dies were fo merly made of steel. The single die used with rubber may be made of softer material, such as plastics or zinc, which can be designed more quickly, thu saving valuable time in the tooling process. United States Rubber Company.

Individual Airplane Hangar

In large hangars, when wind velocities were high enough to make opening large doors a hazard, it was customary to open them only as wide as the fuselage of the airplane was long, and then to "angle" the airplane through the doors. By using this idea, a manufacturer has brought individual hangar construction costs down by 50 per cent or more for all-steel, all-weather hangars with all-weather doors. This was accomplished by eliminating the 40-ft. heavy trusses necessary in the conventional "T"-type hangar with the unsupported 40-ft. front. Not only did the trusses have to sustain the dead weight of the building, but also snow and door loads.

With this new idea, it is possible to shorten the width of the door by 10 or 12 ft. and to use the column placed in the usual free span for the purpose of cantilever truss construction, which in no case requires a truss over 20 ft. in length. The diamond truss formation in the roof stresses the structure for both snow and wind loads, at the same time lightening the steel and retaining a sturdy structure.

The doors, always a high-cost feature for any hangar, have been cut down to two 14-ft. sliding doors. The doors are included in the overall price of the structure and are sufficiently tight for protection against wind, snow, and rain.

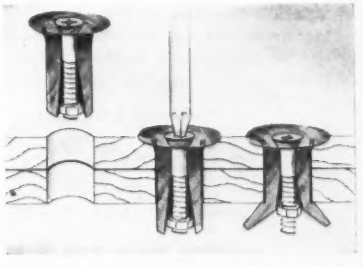
The manufacturer has provided mechanical fasteners that make it possible for laymen to erect those structures with little or no experience. The cement piers are poured and bolted to the frame after it has been erected on comparatively level ground, eliminating another high-cost feature. The roof and siding are of corrugated steel, factory-painted with red lead, affording the owner opportunity to paint the structure in any color desired. Galvanized metal being extremely difficult to see from the air, it was thought that multicolored paint schemes would make an airport easily discernible from the air and add to the beauty of the airport. Universal Corporation, Dallas, Tex.

Blind Bolt Assembly

The "Des-Bolt," another plastic fastening device, is composed of a molded plastic expansion sleeve and any standard nut and bolt assembly of the correct size to match the sleeve. The sleeve is the important element of the design and makes possible the simplicity of the device. The sleeve is composed of three thin fingers with an inside taper extending approximately three-fourths of their length from the flanged head. The head is a flange with a cored hole to accommodate the bolt shank, and countersunk to receive the standard countersink type of bolts, with three sharp ribs attaching the flange and sleeve. These thin ribs wedge into the work and prevent the sleeve from turning.

To apply, the assembled unit is inserted into a drilled hole the size of the outside diameter of the sleeve, the unit is tapped lightly with the screw driver and the bolt tightened. The nut is restrained from turning by the inside tapered surface of the prongs of the sleeve. As the bolt is turned, the nut is drawn into the tapered prongs and begins to force the prongs outward. As the pressure increases by turning of the bolt, the work is drawn together, the sleeve preventing the turning of the nut, and as the point of desired pressure is reached the "Des-Bolt" assembly has securely fastened the components.

When used in the fabrication of laminate sections for such applications as partitions and walls, the device is reported to prevent marring of the surface, can be used where the hardness of the material being fastened would prevent the use of nails or screws, and can be applied by one man from one side of the partition.



Blind expansion bolt manufactured by Victory Manufacturing Company. Plastic sleeve holds nut and bolt *(left)*, is inserted in drilled hole *(center)*, and, as bolt head is tightened, sleeve fingers expand to prevent nut from turning and securely clamp the work being fastened.

VIBRATION TEST
1000 VPM — ½" TRAVEL
NO LEAKS*

*From Underwriters' Laboratories' Report No. 42C649 "Superseal Fittings made up with both steel and copper tubing were mounted between a rigid plate and a vibrating panel. An internal pressure of 50 psi was maintained. The samples were subjected to 1000 vpm with a double amplitude of ¼". *After 30 hours, no leakage had occurred and there was no indication of loosening of the nuts or cracking of the tubing.*"

SUPERSEAL
Flared Tube Fittings

provide leakproof joints even under maximum vibration and pressure

Check these other features

√ Long 10° Tapered Cone provides greater seating area for tubing flare.

√ All Tubing Easily Flared to Superseal's 10° angle... production flaring of welded steel tubing in one operation.

√ No Shearing Action to injure the tubing at the point of flare when the nut is tightened – instead the tubing is actually strengthened.

√ Inside Diameter of Tubing uniformly maintained . . . no obstructions at the joint.

√ Two-part Fitting . . . no rings, no sleeves.

√ Tubing Bends can be made close to the fitting.

√ Materials . . . Stocked in steel. Malleable iron, brass, aluminum or alloys on special order.

√ Complete Line . . . Elbows, tees, and adapters. Steel – to ½" O.D.

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Sizes range, in present production, from 1/4 in. to 3/4 in. in diameter by 1/4 in. to 3 in. in length. Special sizes may be ordered. The work being fastened can vary as much as 50 per cent of the length of the sleeve without adversely affecting the application or security of the fastening. Slot or Phillips-type bolt heads may be used. Victory Manufacturing Company, South Pasadena, Calif.

Adjustable-Range Force-Measuring Spring

A force-measuring beam provides comparable deflections under such widely divergent load ranges as zero to 4,000 lbs., zero to 20,000 lbs., and, the maximum, zero to 100,000 lbs. The new measuring beam has a stiffness that can be varied in accordance with the desired load range.

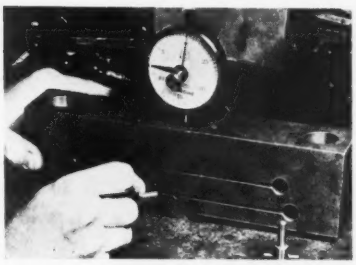
In most testing machines it is necessary to change the force-measuring system when testing materials requiring widely varying loads. If the usual force-measuring spring is made with sufficient strength and stiffness to withstand maximum loads of 40,000 to 50,000 lbs., it is so designed that the deflection under such loads is substantial and easily measured with a suitable extensometer.

For light loads the deflection of such a spring is obviously smaller. For a 4,000-lb. load, the ratio of movement to that of maximum loading is as high as 12.5 to 1, with corresponding decrease in measurement accuracy.

In one conventional type of equipment used in testing materials in tension, the screw jack exerts a force on the bottom of the slotted force-measuring bar. An extensometer is mounted on the top of the bar. The extensometer probe extends down through a vertical hole drilled in the bar and rests against the top of the lower section. Any change in the force exerted against this lower section by the screw jack moves this probe and the change is registered on the extensometer. When the necessary force is applied by the motor-driven screw jack, the force-measuring spring is deflected a certain distance.

Contacts in the extensometer, through electrical controls, limit this deflection (hence the applied force) by stopping the drive motor. When the material under test elongates to such an extent that the deflection of the weighing bar drops below a preset figure, electrical contacts again activate the motor-starter control and re-establish the original force on the bar. Thus a constant force is maintained on the beam and a constant load on the specimen material.

The spring with easily varied stiffness is made in a similar manner, except that there are three slots instead of one. In the center of two slots transverse holes have been drilled. The lower slot is long and relatively close to the bottom of the beam. This is the most easily deflected portion of the bar. Should the force involved exceed the resistance of this section, short steel pins can be inserted into the drilled-out places in the center of the slot. (Because the extensometer probe extends from the top of the spring through a vertical hole in the center, the steel pins cannot extend entirely through the thickness of the spring. A short pin is placed in the drilled-out portion of the slot from each side, avoiding interference with the extensometer probe.) Thus the lower section is firmly coupled to the middle section and utilizes the stiffness of both.



Changing the range of a weighing beam on a Westinghouse Electric Corporation's automatic creep-testing machine.

Should additional stiffness be required, pins inserted in the hole in the second slot cause the force to be opposed by three sections of the beam, providing a maximum of stiffness.

With the new weighing bar it is possible to run tests on such widely dissimilar materials as steel, copper, porcelain, and plastics, and obtain in each class the same degree of accuracy in measuring the stresses involved. By matching the stiffness of the beam to the forces required by the different tests, approximately the same degree of deflection is obtained in each case and the accuracy of the results is comparable.

With the usual single-slot bar, the disparity in deflection under loads of 4,000 and 100,000 lbs. per sq.in. is a measure of the difference in accuracy and ease of control. Westinghouse Electric Corporation.

The Tympanometer—A Swallow Counter

The function of the electric tympanometer is to measure the number of swallows a flier makes during high-altitude flight in order to equalize the pressure on both sides of his eardrums. It obviates the necessity for a physician to enter a high-altitude chamber with a prospective flier in order to count the swallows and assures a more accurate examination.

The innovation consists of instruments that appear to be oversized earphones with "horns." These are clamped on the head of the flier, an earpiece over each ear. Against each ear of the subject are placed fluid-filled chambers. The fluid rests against the eardrum on one side and on the other against a diaphragm in the "earphone." The "earphone" is a microwave transmitter, the "horn" its antenna. With each swallow the diaphragm, coupled by the liquid to the eardrum, moves a pin within the instrument. This movement of the pin causes a peak in the transmitted wave. Thus the record of a compensation appears as a peak in an otherwise smooth graph.

The problem of transmitting the impulses to the recorder outside the high-altitude chamber is essentially one of telemetering. Because the chamber is a metal enclosure, the receiving antenna is strung inside, emerging by means of a coaxial cable. Accurately plotted graphs of swallows versus altitude (or pressure) are made without the doctor being required to undergo the discomfort of the high-altitude cycle.

Swallowing is a voluntary compensation for difference in altitude. There are other entirely involuntary compensations of great importance in determining the fitness of an individual for high altitudes. The result of these involuntary accommodations, also equalization of pressure on both sides of the tympanum and the rate of response of these to outside pressure variations, are also shown by the tympanometer. Westinghouse Electric Corporation.

Changes of Address

To facilitate the prompt receipt of copies of the JOURNAL and REVIEW, members and subscribers are requested to give the editorial offices 30 days' notice of any change of address.

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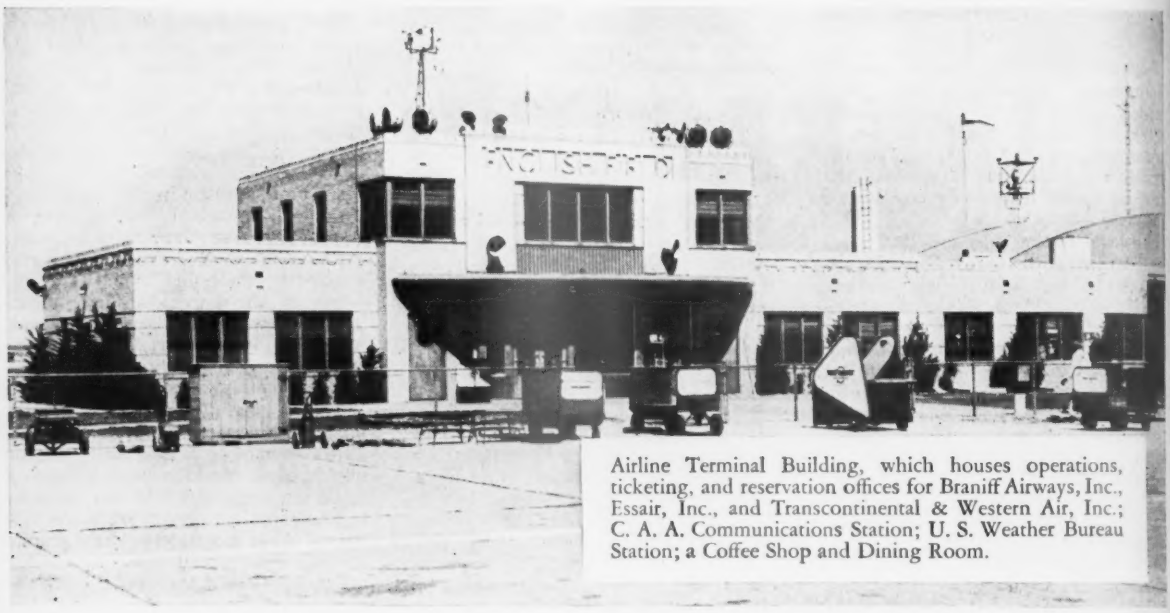

Airline Terminal Building, which houses operations, ticketing, and reservation offices for Braniff Airways, Inc., Essair, Inc., and Transcontinental & Western Air, Inc.; C. A. A. Communications Station; U. S. Weather Bureau Station; a Coffee Shop and Dining Room.

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Above—Panorama of buildings on English Field showing, from left to right, Airline Terminal Building, Private Fliers Terminal Building, Hangar No. 1, and Hangar No. 2.

At left—C. H. Knupp, one of the people who helped make English "the friendly field" has been Airport Manager for the past 11 years.

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